

PFA-100® Platelet Function Analyzer

Service Manual



247299A-046

Copyright 1998 Dade Behring Inc.

This manual contains the information necessary to install, maintain, troubleshoot, and repair the PFA-100[®] Platelet Function Analyzer. All procedures in this manual should be performed only by an authorized service representative.

The PFA-100[®] has been fully tested for Year 2000 compliance.

WARNING: *All technical service representatives operating the PFA-100[®] analyzer must first read this manual. Operating the system without knowledge of its procedures could injure the operator or damage the system.*

Safety Compliance

The PFA-100[®] has been designed and tested to comply with safety standards UL3101-1, CSA C22.2#1010.1 and EN61010-1 under the following environmental condition [subclause 1.4]:

Temperature	5–40°C (41–104°F)
Relative Humidity	Maximum 80% at 31°C to 50% at 40°C
Altitude	Maximum 2,000 m (6,562 ft)
Supply Voltage	100 V ac - 130 V ac, 60 Hz 200 V ac - 250 V ac, 50 Hz
Overvoltage	
Pollution Degree	Degree 2, normal indoor laboratory environment.

Emissions Compliance

The PFA-100[®] has been designed and tested to CISPR 22 Class A. In a domestic environment it may cause radio interference, in which case you may need to take measures to mitigate the interference.

Barcode Reader

The Barcode reader uses Class I light emitting diodes (LEDs). There is no eye hazard.

I/O Cable

The I/O cable must be shielded such that the shield conductor is common with the conducting shell in the terminating conductor.

Technical Updates

Dade Behring periodically provides technical updates to the *PFA-100® Service Manual*. To keep this manual current, integrate these updates into the manual by following the directions that accompany each update package. Use the update log on the next page to track each update received.

Dade Behring Technical Assistance Center

The 24-hour, toll-free Technical Assistance Center is staffed by Dade Behring System specialists and engineers ready to answer questions on system operation, maintenance, repair, and troubleshooting, and to set up service calls. If at any time the device fails to perform as described, contact technical support by calling the toll-free number:

1-(800) 242-DADE or 1-(800) 242-3233.

Update Log

Use this update log sheet to record updates received for this *PFA-100® Service Manual*. Updates will be issued periodically and assigned a number corresponding to this log sheet. When you receive an update, check the appropriate box on this page. An instruction sheet accompanying the update describes which pages to discard and where to insert the new updated pages.

1	2	3	4	5	6	7
8	9	10	11	12	13	14

TABLE OF CONTENTS

Section 1. System Overview	1-1
Instrument Geography	1-1
Theory of Operation	1-2
Functional Description	1-2
Instrument Features	1-3
Instrument Subsystems	1-3
Procedure to Transmit Data to Host Computer	1-7
Cable Connection	1-8
Communication Parameters:	1-8
Instrument Circuit Boards	1-8
General Troubleshooting	1-9
Special Function Menus	1-9
Overview	1-9
Section 2: Sample Transport and Incubation System	2-1
System Components	2-1
Error Messages and Causes	2-2
Carousel Drive Failure—Please Check for Obstructions	2-2
Carousel Drive Failure	2-2
Incubation System Fail	2-3
Replacement Procedures	2-4
Replacing the Heater Block Assembly (P/N 9800-2165)	2-4
Replacing the Carousel Pump Motor (P/N 9800-2634)	2-8
Sample Transport and Incubation System Adjustments	2-10
Carousel Pump Motor Belt Tension	2-10
Carousel Home Sensor	2-10
Section 3: Vacuum Control System	3-1
System Components	3-1
Error/Status Messages and Causes	3-2
Syringe Pump Drive Fail (Error Message)	3-2
Test Terminated Due to Maximum Syringe Travel Being Reached (Status Message)	3-4
Test Terminated Due to Air Leak (Status Message)	3-5
Vacuum Chuck Drive Failure (Error Message)	3-6
Vacuum Test Failed (Error Message)	3-8
Replacement Procedures	3-10
Replacing the Syringe Pump Motor (P/N 9800-2633)	3-10
Replacing the Syringe Sensor Assembly (P/N 9800-2584)	3-12
Replacing and Lubricating the Syringe Tip (P/N 5601-0972)	3-12
Replacing the Vacuum Chuck Assembly (P/N 9800-2587)	3-14
Replacing the Vacuum Chuck Interrupter (INT) Sensor Assembly (PN 9800-2154)	3-17
Replacing the Vacuum Chuck Motor Assembly (P/N 9800-2161)	3-18
Replacing Vacuum Tubings and Fittings	3-20

Section 4: Trigger Solution Dispense System	4-1
System Components	4-1
Error Messages and Causes.....	4-2
Trigger System Failure.....	4-2
Solenoid Pump Sticking Corrective Action	4-5
Replacement Procedures.....	4-8
Replacing Trigger Bottle Traveler Assembly (P/N 9800-2170).....	4-8
Replacing the Bottle and AIL Sensor Assembly (P/N 9800-2169).....	4-10
Replacing the Self-Priming Solenoid Pump (P/N 5601-0966).....	4-11
Replacing the AIL Tubing.....	4-13
Replacing and Aligning the Type Code Sensor and Trigger Dispense Tube.....	4-15
Section 5: Instrument Control System and Power Supply	5-1
System Components	5-1
Error Messages and Causes.....	5-2
Main Memory Error	5-2
Maximum PID Length Exceeded	5-3
Printer Fail (Error Message).....	5-4
RAM Memory Error.....	5-6
Test Canceled - No Control Number Entered - Press Continue	5-6
Maximum Test Time Exceeded.....	5-6
Replacement Procedures.....	5-7
Replacing the Display Assembly (P/N 9800-2175)	5-7
Replacing the Printer Assembly (P/N 9800-2174)	5-9
Printer Driver Board Assembly (P/N 9800-2173).....	5-12
Replacing the Main PC Board Bracket Assembly (P/N 9800-2150)	5-14
Power Supply	5-15
Error Message: If Instrument is Not Operating (no power)	5-15
Replacing the Baseplate Assembly (P/N 9800-2160)	5-15
Section 6: Service Spare Parts.....	6-1
How to Order Spare Parts	6-1
Section 7: Testing and Maintenance.....	7-1
System Self-Test.....	7-1
Self-Test Procedure	7-1
PFA Tester	7-2
Theory of Operation	7-2
Setup.....	7-3
Operating Instructions	7-3
Preventive Maintenance	7-6
Cleaning the O-Ring (P/N 5601-0891)	7-6
Instrument Decontamination Procedure	7-7
Required Equipment.....	7-7
Decontamination Procedure	7-7
Section 8. Quick References	8-1
Self-Test Troubleshooting Diagram.....	8-1
PFA-100® Troubleshooting System Diagram	8-2
Manufacturing Documentation Reference List.....	8-3

Appendix: Technical Information.....	A-1
Main Board	A-1
Microprocessor.....	A-1
Ranges and Conversion Factors.....	A-1
Reset Monitor	A-1
System Memory	A-2
Flash Memory	A-2
Memory Card Connector.....	A-2
Motion Control	A-2
Servo Motor Drive System.....	A-2
Stepper Motor Driver	A-3
Peripherals	A-4
RS-232 Outputs	A-4
Barcode Reader	A-4
Sensors	A-7
Vacuum Sensor.....	A-7
Cartridge Identification (TC) Sensor.....	A-7
Air-in-Line Sensor.....	A-7
Position Sensors	A-8
Micro Pump	A-8
Front Panel Keypad	A-8
Power Supply	A-8
Precision Voltages.....	A-9
Printer	A-9
Fusing	A-9
Beeper.....	A-10
Manufacturing Special Menu Functions.....	A-10
Overview	A-10
Manufacturing Test Menu #1	A-10
Manufacturing Test Menu #2	A-15
Manufacturing Test Menu #3	A-18
Trigger System Purge Function.....	A-21
Schematics	(See Schematics tab in manual.)
Main PC Board Schematic Diagram (PN 4240-0178)	
Interface PC Board Schematic Diagram (PN 4240-0177)	

Section 1. System Overview

Instrument Geography

Figure 1-1. Front View of PFA-100® (Covers Removed)

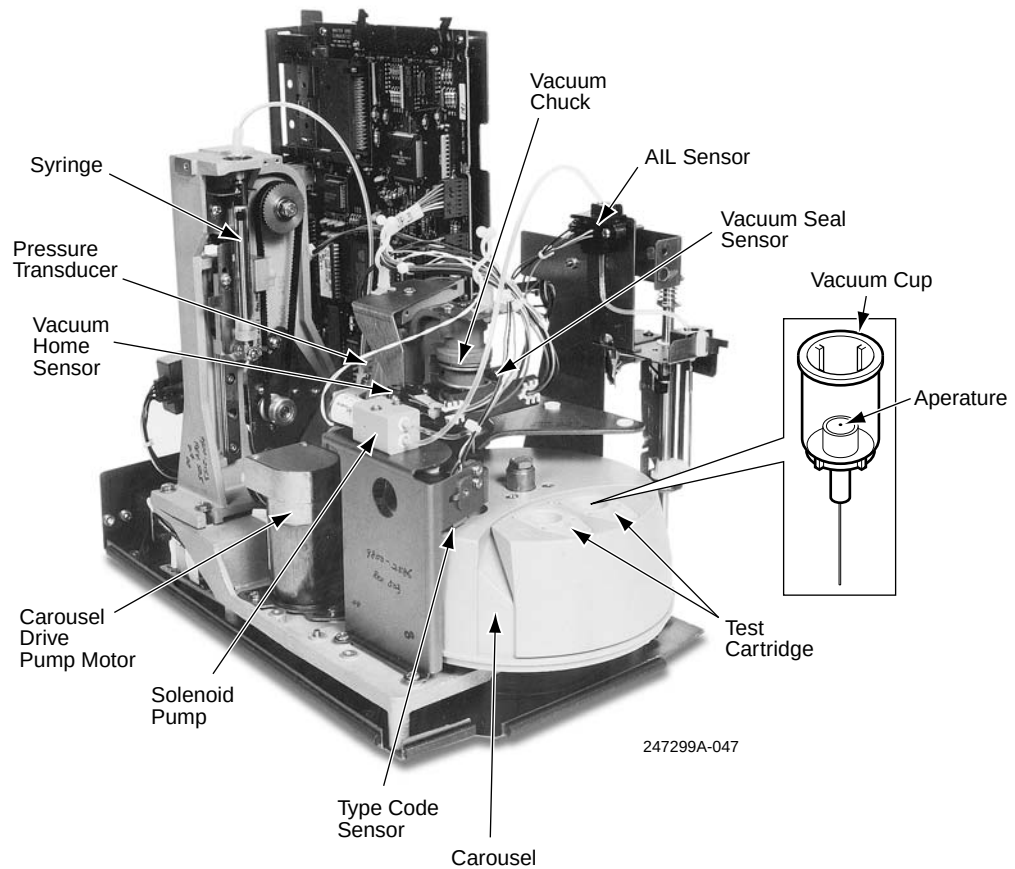
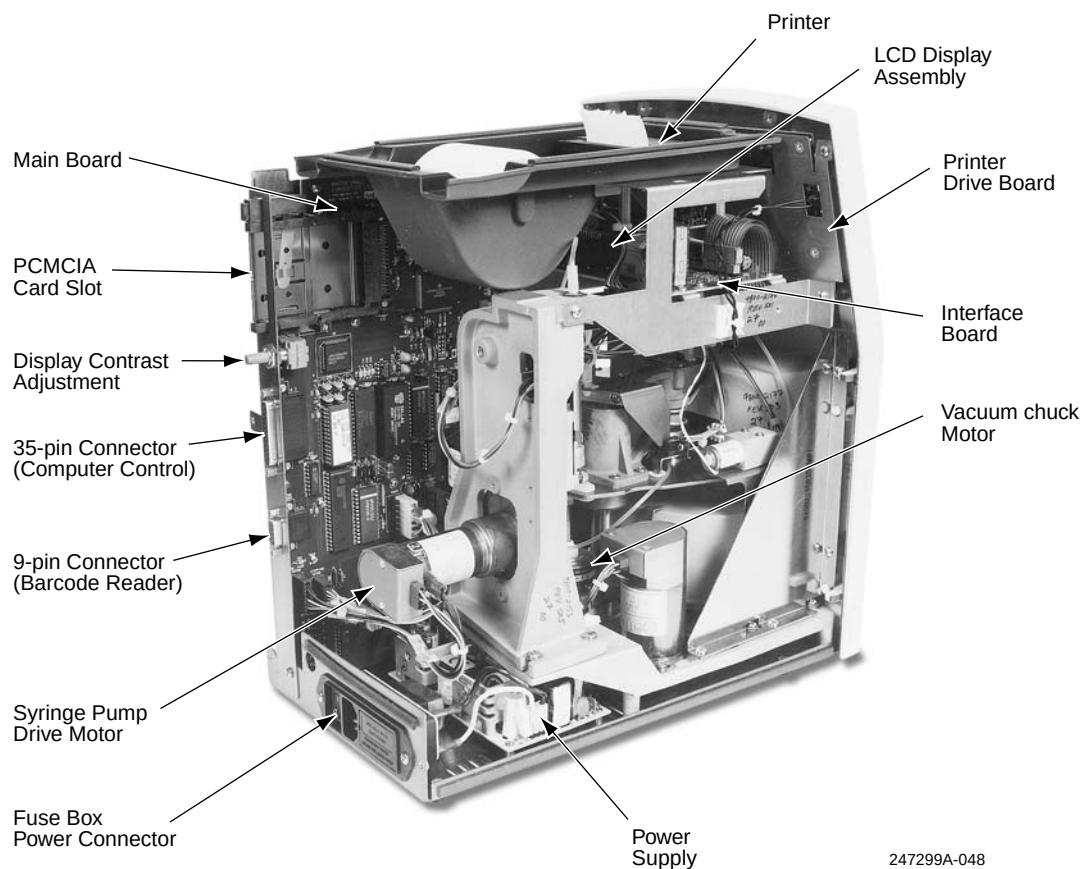


Figure 1-2. Back View of PFA-100® (Covers Removed)



Theory of Operation

The PFA-100® test uses whole blood samples collected in 3.8% or 3.2% sodium citrate anticoagulant. It does not require any special blood-drawing procedure. The sample is aspirated through the capillary into the cup, contacts the coated membrane, and then passes through the aperture (refer to the detail view in Figure 1-1).

In response to the stimulation by collagen and epinephrine or ADP present in the coating and the shear stresses at the aperture, platelets adhere and aggregate on the collagen surface starting at the area surrounding the aperture. During the measurement, a stable platelet plug forms and ultimately occludes the aperture. The time required to occlude the aperture is defined as the Closure Time and indicates the platelet function of the sample.

Functional Description

The PFA-100® platelet function analyzer is designed for in-vitro measurement of platelet function in anticoagulated whole blood. The PFA-100® system has been developed to aid in detecting platelet dysfunction accurately, quickly, and quantitatively.

The PFA-100® performs a test by positioning a hydrated test cartridge containing blood under the vacuum chuck. After incubation, the vacuum chuck motor lowers the chuck to seal the top of the cartridge. The syringe motor is driven to aspirate a vacuum in the test chamber of the cartridge. The processor monitors the output of the vacuum sensor. When the output indicates 40 mbar of vacuum, the test starts. The 40-mbar vacuum causes blood to flow up the capillary tube in the test cartridge. The processor, vacuum sensor, and syringe drive form a closed loop system that maintains the 40-mbar vacuum by aspirating air from the test chamber of the cartridge at the same rate as blood flows in through the capillary tube.

The speed of the syringe motor therefore represents the flow rate of blood entering the test chamber. The change of syringe motor speed represents the actions of the platelets in the sample to form a plug and stop the flow of blood. When the flow rate falls to a level determined by software, the test ends and the test time is reported as the closure time. During the test, the processor reads encoder counts from the syringe motor controller. This information is applied to the software algorithm to determine flow rate and closure time.

Instrument Features

- Easy to operate
- No sample preparation
- Walk-away design (minimal operator interaction)
- Fast results
- Accurate
- Quantitative
- Self-contained, fully disposable single-unit test cartridges

The system has a number of quality control features such as complete self-test of the main mechanical and electrical components and a test of the integrity of the vacuum system. The system also contains a number of semi-automated maintenance features that can be easily performed by the operator.

Instrument Subsystems

- Sample transport and incubation system
- Vacuum control system
- Data management system
- Instrument control system
- Trigger solution dispense system

The instrument normally operates in stand-alone mode. An optional barcode reader is available for clinical centers using a barcode sample identification system.

Sample Transport and Incubation System

The PFA-100[®] test cartridges load into a cassette. The blood sample is added to the test cartridges in the cassette and then placed on the carousel. The carousel contains the incubation system that places the incubation well temperature at $37.9 \pm 1^\circ \text{C}$. The samples can be run individually or in duplicate. When run in duplicate, the measurements are performed sequentially.

At the beginning of the test sequence, the carousel turns to register the cartridges under the dispense nozzle where $40 \pm 4 \mu\text{L}$ of saline trigger solution is dispensed onto the membrane to solubilize the epinephrine or ADP. While the carousel is turning, the cartridges pass under the type code sensor. This is where the cartridge type and its location on the carousel are determined. Immediately after the trigger dispense, a three-minute incubation cycle is initiated and followed by the actual test measurement. After completion of the test sequence, the carousel returns to the initial start position where the used cartridges can be removed and disposed of by the operator.

PFA-100[®] Test Cartridge

The PFA-100[®] uses completely disposable single-unit cartridges consisting of a cup/capillary assembly and a housing/sample reservoir. The cup/capillary assembly contains a polypropylene cup in which a biologically active membrane disc is placed. An aperture (approximately $150 \mu\text{m}$ diameter) is created at the center of the membrane disc with a precision mechanical punch system.

A polypropylene hub containing a stainless steel capillary ($200 \mu\text{m}$ internal diameter) is ultrasonically welded to the bottom of the cup. A thin plastic separation membrane located at the top of the sample reservoir prevents blood contact with the capillary during the incubation period.

At the beginning of the test, the capillary is forced down by the vacuum chuck through the separation membrane into the sample reservoir. After passage through the aperture, the waste sample accumulates in the cup and the entire test cartridge is discarded by the operator at the end of the test.

The polyethylene housing/sample reservoir has an opening on the top for easy sample loading. The bottom chamber is sealed with laminated aluminum foil where the sample is incubated before analysis. During fabrication of the test cartridges, the cup/capillary assembly is placed in the housing and a removable laminated foil cover is placed on the top of the housing. The test cartridges are packaged under desiccated conditions in hermetically sealed, reclosable laminated aluminum foil bags.

Membrane Constituents

The membrane in the PFA-100[®] test cartridge serves as a support matrix for the biological components and allows placement of the aperture. The membrane consists of a standard nitrocellulose filtration membrane with an average pore size of $0.45 \mu\text{m}$. The blood entry side of the membrane is coated with $2 \mu\text{g}$ of fibrillar Type I equine tendon collagen, and $10 \mu\text{g}$ of epinephrine bitartrate or $50 \mu\text{g}$ of adenosine 5'-diphosphate (ADP). These agents provide controlled stimulation to the platelets as the blood sample passes through the aperture.

The collagen surface also serves as a well-defined matrix for platelet deposition and attachment.

The PFA-100[®] test cartridges have all of the bio-active components placed within the membrane. The PFA-100[®] with collagen/epinephrine test cartridges, was able to detect aspirin-induced platelet dysfunction in a group of volunteers for several days following aspirin ingestion, in addition to other types of platelet dysfunction.

Vacuum Control System

The vacuum control system consists of a vacuum chuck that interfaces with the test cartridge, a continuous servo-motor driven syringe, a pressure transducer, and a feedback loop controller. The vacuum chuck engages with the cup in the test cartridge. An O-ring placed within the chuck forms an air-tight seal. The vacuum is created by the displacement (motor-driven) of the syringe piston. The movement of the piston is controlled such that the internal vacuum level remains at 4 kPa (40 mbar, -0.58 Psi). As the platelet plug starts to form at the aperture, the rate of displacement of the piston reduces and eventually stops when the aperture is occluded.

Instrument Control System

The instrument control system of the stand-alone PFA-100[®] consists of a front panel keyboard, a liquid crystal display (LCD), an impact printer, and data storage and retrieval components. The keyboard allows the user to input numeric patient identification numbers and to select various instrument functions. The LCD operates as the main user interface for system setup, configuration, and menu-driven selection of instrument and test options. The LCD also displays the test results at the completion of a test. The impact printer is used to print the test results as well as certain instrument and test parameters on plain paper tapes.

In the stand-alone mode, the PFA-100[®] allows the user to store up to 20 test results in memory. The results can also be retrieved and printed when requested by the user. The normal range of PFA-100[®] test is established at each individual site by analyzing blood samples from normal volunteers. The user can set up the system to “flag” test results that do not fall within the established normal range.

If normal blood samples are analyzed as part of the periodic quality control procedure, up to 50 such control measurement results could be stored, retrieved, and printed.

The PFA-100[®] system uses a highly integrated microcontroller chip as the central “manager” of all functions. All external (keypad, barcode reader, and external PC) and internal (vacuum sensor, position sensors, etc.) inputs are fed to the microcontroller. The microcontroller uses these inputs when deciding what actions the system should take. The “instructions” that direct the microcontroller are stored in an EEPROM memory device. Future enhancements or changes to these “instructions” can be easily field-updated by use of a Personal Computer Memory Card International Association (PCMCIA) card that plugs into a slot in the back of the unit.

The functions of each of the major subsystems within the PFA-100[®] instrument are monitored by sensors that return the status information to the microcontroller. If a problem is detected, the microcontroller will announce this information on the front panel display and take appropriate action to prevent erroneous results from being reported.

Trigger Solution Dispense System

Standard isotonic 0.9% sodium chloride solution is used as the trigger solution. The trigger dispense function is performed by the micro pump. The micro pump withdraws 40 ± 4 μ L of trigger solution from the vial through a vented needle. Just before incubation, the trigger solution is dispensed through a nozzle mounted on the type code sensor bracket.

The trigger solution permeates the membrane during incubation and solubilizes the epinephrine or ADP present in the dry state within the membrane. The system uses two sensors to detect if a trigger vial is loaded in the instrument bottle sensor and if the vial has run out of trigger solution (air-in-line detector).

Data Management System

If results data is to be collected, a built-in option in each PFA-100[®] can accomplish the task. The option is called Laboratory Information System (LIS). This option allows the user to transmit the printed results to a host computer. Each result is transmitted from the PFA-100[®] with a checksum. The format for the checksum line is: cs:nnnnn<CR><LF>. It is the responsibility of the user to ensure that the data received on the host computer is accurate. To do so, the communication software should be able to calculate the checksum value by adding up the transmitted characters one byte at a time, starting with the first character of the header until the last character before the checksum line (which will be an LF [line feed] character ASCII 0A). The checksum is a two-byte modulo 65536 value. Each line has a <CR><LF> at the end.

Procedure to Transmit Data to Host Computer

1. Connect serial cable from 25-pin connector (PFA side) to 9-pin connector (host computer side).
2. Press “Menu” softkey. Enter the following:
 - “3” for setup
 - “2” for set defaults
 - “4” for LIS
3. Press “Enable” softkey. (See examples on next page.)

Example of transmitted results:

PFA-100®
REV. 1.30 g S/N: 99005
4/7/97 10:53 PM
ID# 1
Test Type: Collagen/ADP
SAMPLE A: 81* SEC
cs: 6648

PFA-100®
REV. 1.30 g S/N: 99005
4/2/97 3:18 PM
ID# 18
Test Type: Collagen/EPI
SAMPLE B: 75* SEC
cs: 6624

Cable Connection

PFA Side : DB-25 Male connector

Computer side: DB-9 Female [(short pins 1,4,6) (short pins 7,8)]

Connection between DB-9 and DB25 are provided in the table below:

DB-9	To	DB-25	Function
Pin 5	To	Pin 7	GND
Pin 3	To	Pin 3	RXDA
Pin 2	To	Pin 2	TXDA

Communication Parameters:

Baud Rate	9600
Parity	none
Data Bits	8
Stop Bits	1

Instrument Circuit Boards

The PFA-100[®] contains the following circuit board assemblies:

- Power Supply
- Main Board
- Interface Board
- Printer Driver Board

General Troubleshooting

The system displays messages on the screen when failures occur. These messages may be either error or status messages. Error messages appear when system failures occur. Test results are invalid. Status messages appear if the system malfunctions but the test continues. Re-run the test.

Special Function Menus

Overview

Caution: Initiating some of these special functions may cause irreversible changes to the PFA-100[®] instrument (e.g., resetting of the memory). Please read and understand the function as described in the following text before proceeding.

The special function menu contains a number of software tools to assist in the production, troubleshooting, and development of the PFA-100[®] instrument. Some of these tools can be useful for the service engineer.

Access to the special function menu is controlled by a special access code. Because of the potential risk of erasing data, the access code should never be provided to a customer. The special function menu is entered using the following procedure:

Note: If a replacement procedure requires you to calibrate or perform special tasks such as entering a serial number through the Special Functions Menu, you will be provided with detailed instructions in that specific replacement procedure.

1. From the main menu, select “Menus.”
2. Press “2” to select Maintenance.
3. Press “9” to select hidden screen access.
4. Enter the access code “10155.”

(Procedure continued on next page.)

A menu with the special functions will be displayed (see the example of a manufacturing test menu below). For a detailed description of each menu function, refer to “Manufacturing Menu Functions” in the Appendix.

Manufacturing Test Menu #1 (Screen E2)

1 Loop Test	5 Calibrate AIL
2 S/N Entry	6 Calibrate TC
3 Display Test	Next Screen
4 Memory Reset	Previous Screen

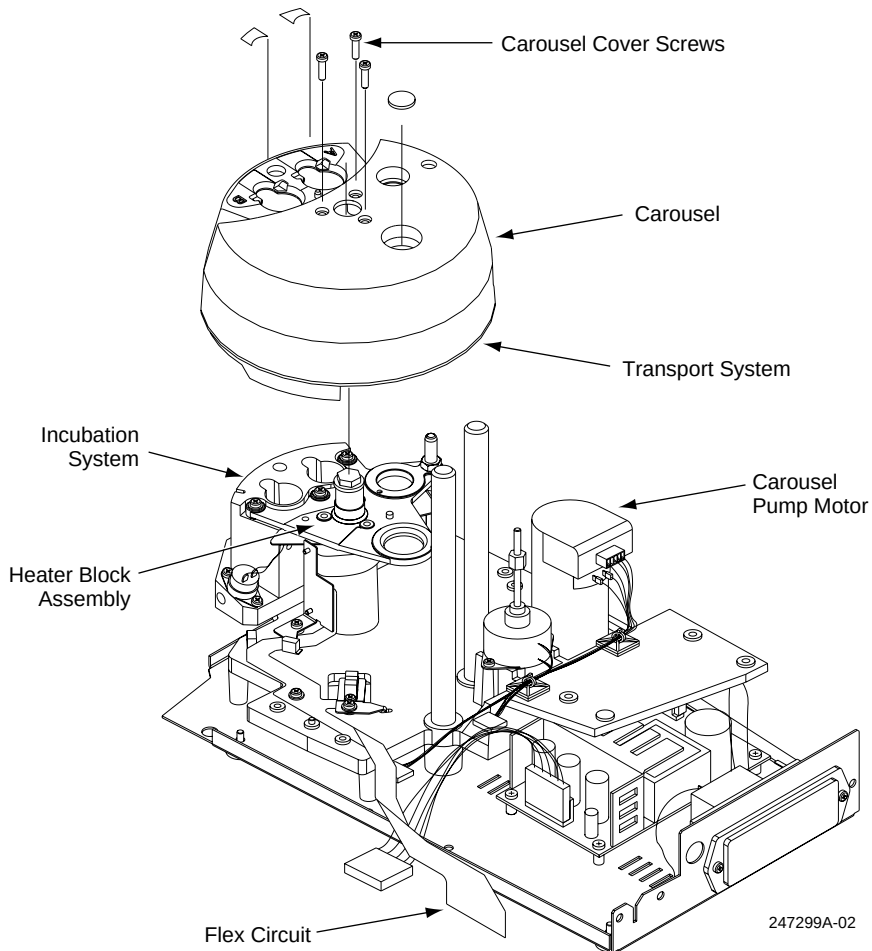
Section 2: Sample Transport and Incubation System

System Components

Components of the sample transport and incubation system include:

- carousel pump motor
- carousel drive belt
- heater block assembly (carousel home sensor, incubation heater rod, thermistor, cut-out switch, and flex circuit)

Figure 2-1. Sample Transport and Incubation System Components



Error Messages and Causes

Carousel Drive Failure—Please Check for Obstructions

The system detects something preventing the carousel from rotating. Ensure that a test cartridge, cassette or other object is not preventing the carousel from rotating. After clearing the obstruction, press “Retry” to retest carousel movement.

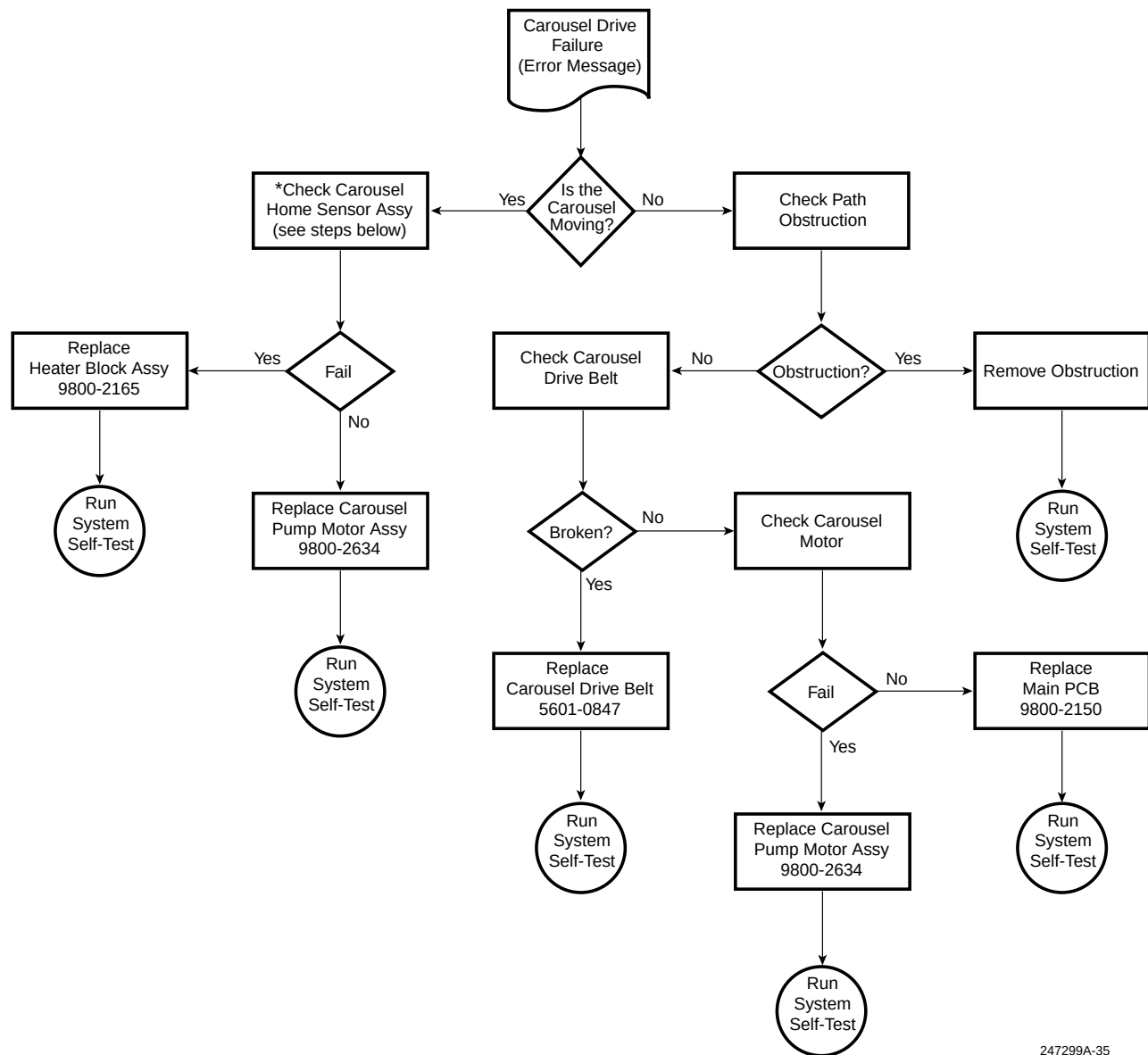
Carousel Drive Failure

The system continues to detect something preventing the carousel from rotating after three retry attempts (described above). If no physical obstructions are present, the error is probably due to an electro-mechanical failure of the carousel drive assembly.

This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved

Possible Cause	Solution	Procedure Used
Carousel home sensor is inoperable or misaligned	Adjust sensor.	Step 13 in Replacing the Heater Block Assembly
Carousel pump motor is defective (either the optical encoder or drive portion)	Replace motor.	Replacing Carousel Pump Motor
Carousel drive belt is loose or broken or drive electronics are defective (main board)	• Check tension on belt. • Replace carousel pump motor drive belt. • Replace main PC board.	• Step 9 in Replacing Carousel Pump Motor • Replacing Carousel Pump Motor • Replacing Main PC Board

(Troubleshooting diagram on next page.)



247299A-35

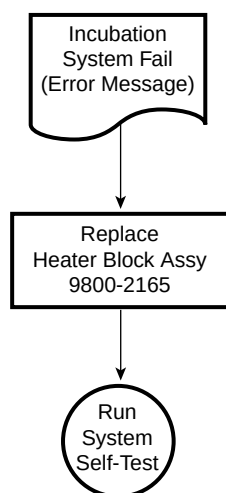
Checking Carousel Home Sensor Assembly

1. Make sure instrument is turned on.
2. Using a voltmeter, place one probe on R23 on the PCB and the other probe to the ground spot.
3. Rotate the carousel to see if the reading on the voltmeter is high (around 5 V) and low (around 0 V). If you do not get *both* high and low readings, the sensor assembly has failed.

Incubation System Fail

The system detects that the heater block is not heating properly. This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved.

Possible Cause	Solution	Procedure Used
Defective heater rod, thermistor, over-temperature cut-out switch or flex circuit.	Replace heater block assembly.	Replacing Heater Block Assembly



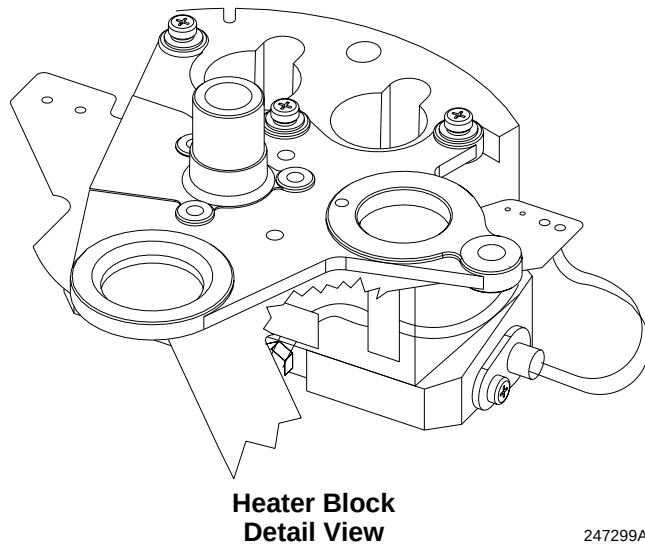
247299A-34

Replacement Procedures

Warning! Make sure instrument power is OFF before replacing these assemblies.

Replacing the Heater Block Assembly (P/N 9800-2165)

Figure 2-2. Heater Block Assembly

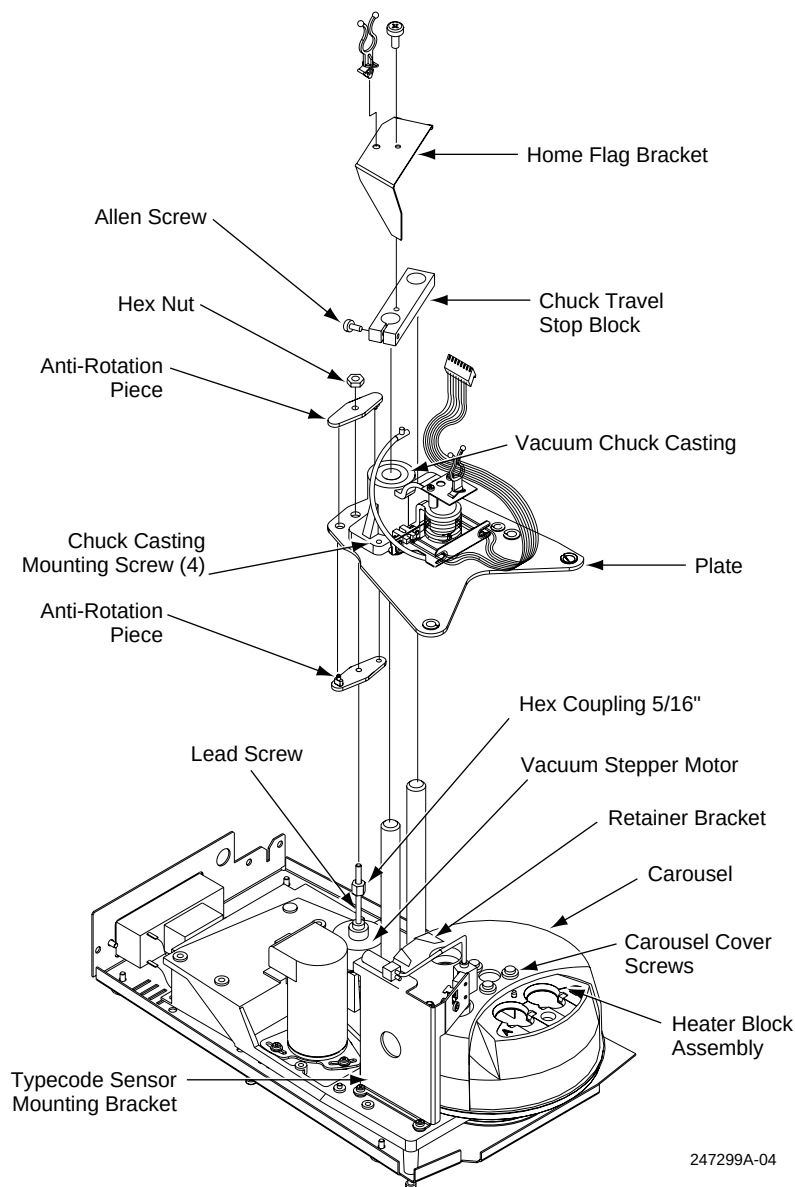


1. Remove the hex nut on the anti-rotation piece. Use caution not to bend the lead screw (see Figure 2-3).

Note: Use open-end wrench (5/16") to hold hex coupling while removing hex nut.

2. Remove the home flag bracket (one screw).
3. Loosen the 7/64" Allen screw, then remove the chuck travel stop block and set it aside.
4. Remove the 4 screws that secure the vacuum chuck casting and plate. Lift them off the vertical shafts and set aside.
5. Remove the type code sensor mounting bracket (2 screws).

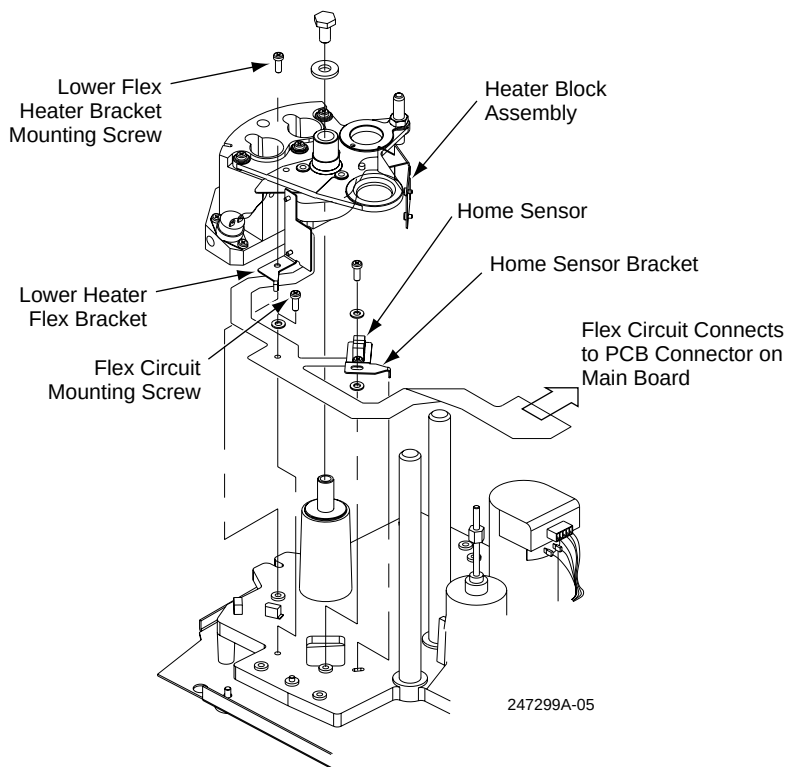
Figure 2-3. Removing the Heater Block Components



6. Loosen the 2 screws on the retainer bracket and push the retainer bracket away from the carousel cover.
7. Remove the 3 screws on carousel cover and set carousel cover aside.
8. Remove the lower heater flex bracket mounting screw (see Figure 2-4).

(Procedure continued on next page.)

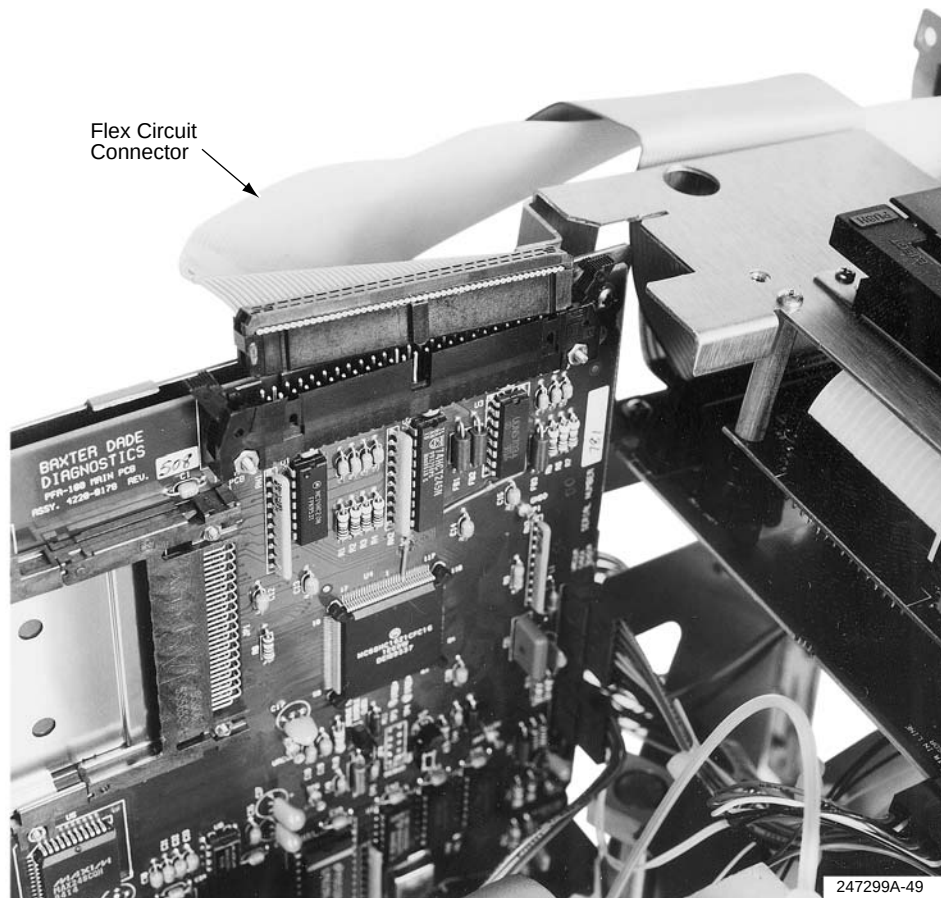
Figure 2-4. Removing the Heater Block Assembly



9. Remove the flex circuit mounting screw. Unplug the flex circuit connector from the connector on the main PC board by squeezing the two tabs on the board connector to release the flex circuit (refer to Figure 2-5).
10. Remove the heater block assembly.

(Procedure continued on next page.)

Figure 2-5. Removing the Flex Circuit Connector from the Main PCB



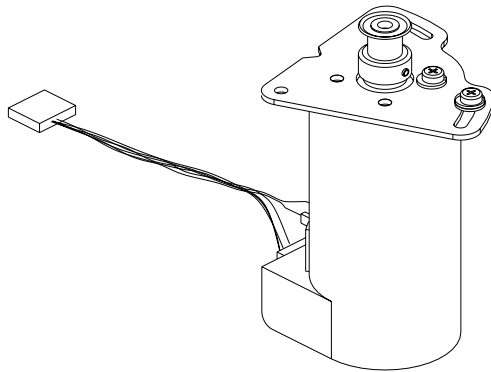
11. Install the new heater block assembly over carousel shaft. Be careful not to damage flex circuit.
 12. Attach lower heater flex bracket to chassis.
 13. Attach flex circuit and home sensor bracket to chassis.
- Caution:** Make sure you adjust the home sensor bracket so attaching fastener is in center of slot. If the sensor bracket is not installed correctly, you may get Carousel Drive Failure error. (Refer to Figure 2-4.)
14. Rotate heater block back and forth on carousel shaft. Verify that service loop on flex circuit moves smoothly without kinking or catching on other components.
 15. Install carousel cover over carousel shaft and tighten screws.
 16. Adjust the position of the retainer bracket so that it is within 1/32 inch of the carousel. The carousel must not touch the bracket as it rotates. Secure the bracket by tightening the vacuum chuck drive motor mounting screws.
 17. Reinstall the vacuum chuck casting using the 4 screws.
 18. Apply Loctite® RC680 to the threads of the vertical stepper motor lead screw.

(Procedure continued on next page.)

19. Reinstall the plastic anti-rotation piece and hex nut that secure the vertical stepper motor lead screw to the vacuum chuck plate.
20. Reinstall the chuck travel stop block and secure using the 7/64" Allen screw, such that the shaft is flush or below the travel stop block.
21. Reinstall the home flag bracket to the top of the chuck travel stop block.

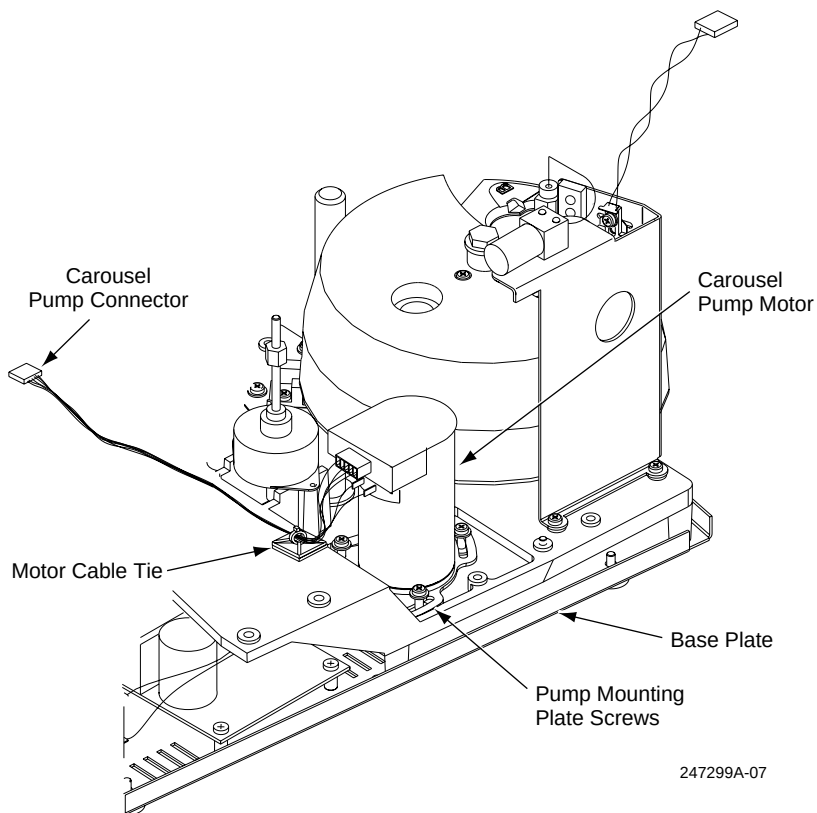
Replacing the Carousel Pump Motor (P/N 9800-2634)

Figure 2-6. Carousel Pump Motor



247299A-09

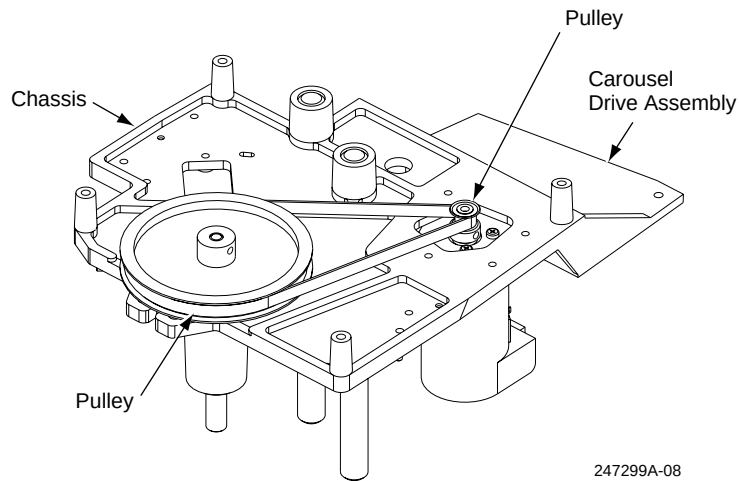
Figure 2-7. Replacing the Carousel Pump Motor



Replacing the Carousel Pump Motor (continued)

1. Loosen chassis from baseplate (4 screws underneath baseplate).
2. Disconnect carousel pump motor wires from main PCB.
3. Loosen mounting plate screws (see Figure 2-7).
4. Take belt off pulleys.
5. Remove the old motor with mounting plate.

Figure 2-8. Removing Belt from Pulleys

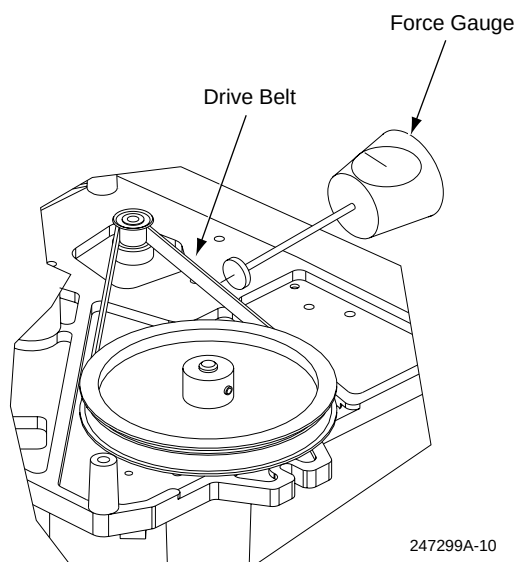


6. Install the new motor by mounting the assembled carousel motor kit (P/N 9800-2634) to chassis. Loosely tighten attachment screws so motor can still pivot.
7. Slip belt over both pulleys.

(Procedure continued on next page.)

8. Tighten belt by swiveling motor and tightening mounting plate screws.
9. Check belt tension with force gauge. Apply 3 ounces of force to the center belt span. Ensure that belt deflection is 0.07 ± 0.02 inches. If deflection is not within tolerance, loosen mounting plate screws and readjust tension until deflection is within tolerance. Refer to Figure 2-9.

Figure 2-9. Adjusting Belt Tension



10. Tighten motor mounting plate screws.
11. Secure motor assembly wires with cable ties.

Sample Transport and Incubation System Adjustments

Carousel Pump Motor Belt Tension

Refer to Step 9 in “Replacing the Carousel Pump Motor” in this section.

Carousel Home Sensor

Adjust home sensor bracket so that the attaching fastener is in center of slot. Refer to Step 13 in “Replacing Heater Block Assembly” (in this section) for more details.

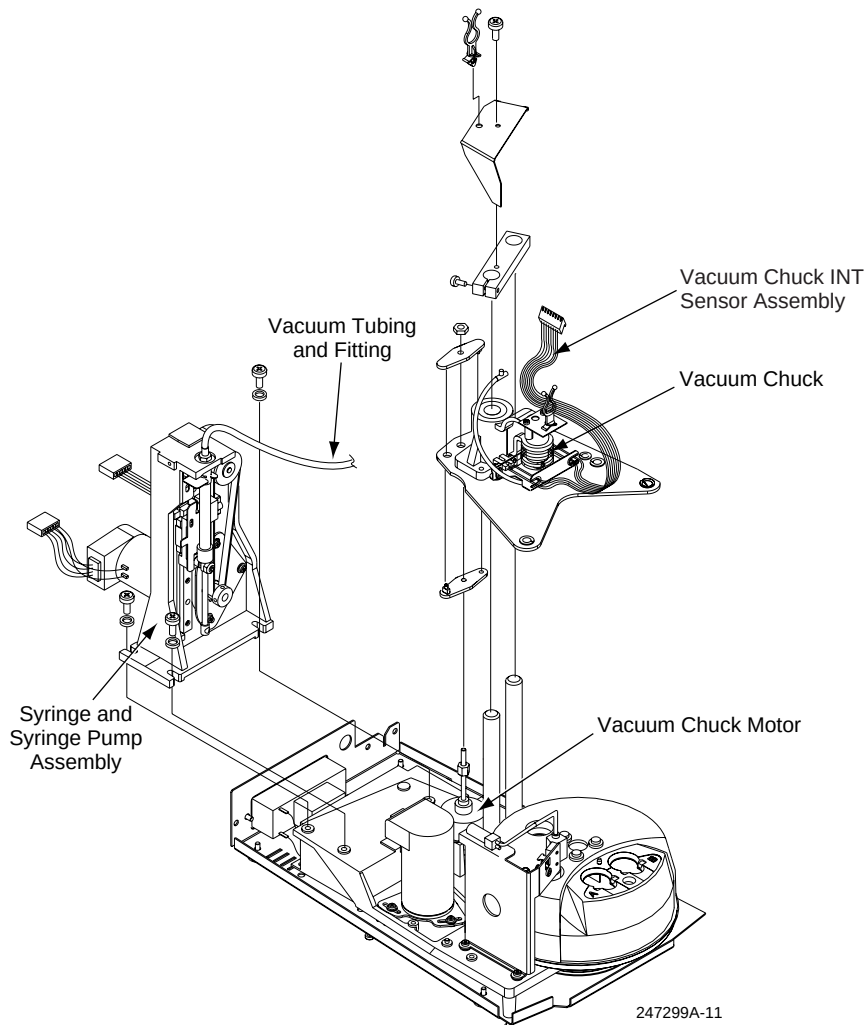
Section 3: Vacuum Control System

System Components

Components of the vacuum control system include:

- syringe pump motor
- vacuum chuck motor
- vacuum chuck
- vacuum tubes and fittings
- vacuum pump motor drive belt
- vacuum chuck interrupter (INT) sensor assembly

Figure 3-1. Vacuum Control System Components



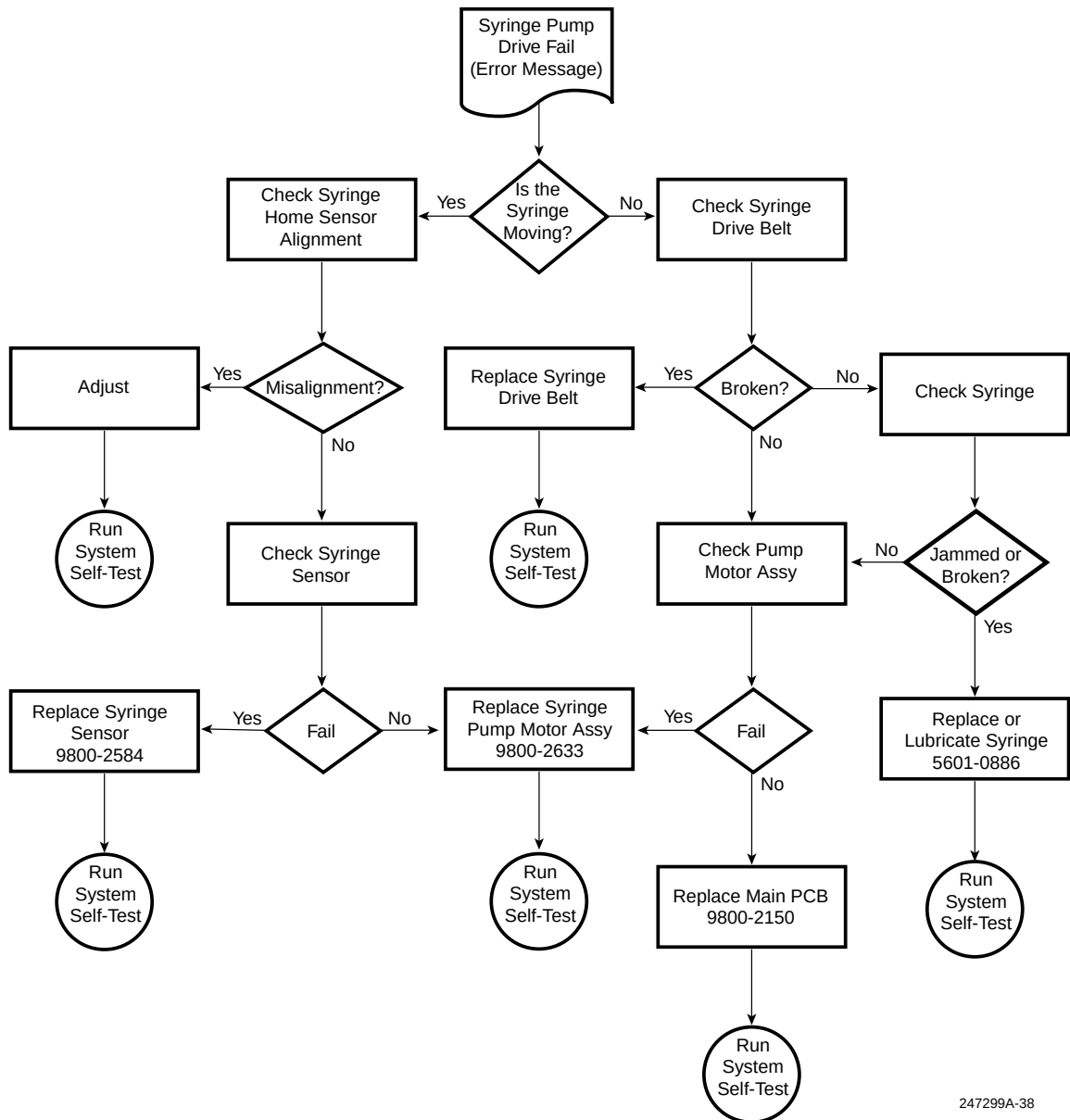
Error/Status Messages and Causes

Syringe Pump Drive Fail (Error Message)

The system detects a problem with the movement of the syringe pump. The syringe pump is also used to create a vacuum in the system, so this message will also occur if a significant vacuum leak occurs during the “Vacuum Leak Test” portion of the self-test. This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved. If this error message occurs during the power-on “Self Diagnostics,” check these possible causes:

Possible Cause	Solution	Procedure Used
Defective syringe pump motor	Replace motor.	Replacing Syringe Pump
Defective motor driver (on main board)	Replace main PCB if defective. After replacing PCB, calibrate AIL, TC and pressure set points.	Replacing Main PC Board
Defective belt or home sensor	• Check tension on belt. • Replace sensor.	Step 8 in Replacing Syringe Pump Motor.
Sticking or jammed syringe or slide rail	• Clean and lubricate syringe or replace it. • Clean slide rail.	Replacing and Lubricating Syringe Tip

(Troubleshooting diagram on next page.)



247299A-38

***Test Terminated Due to Maximum Syringe Travel Being Reached
(Status Message)***

The system stops the current test because it detects that the syringe pump has reached the end of its travel (it has withdrawn its maximum volume) before the flow through the test cartridge aperture has stopped (the end of test). Pressing “Continue” will return you to the System Ready screen or to the Test B status screen, depending on where the error was detected. This error will have no effect on the other test if two tests were being run.

Possible Cause	Solution	Comments or Procedure Used
Insufficient sample in test cartridge, so the system aspirates air before the end of test.	Check that no sample remains in the sample chamber of the test cartridge and that there are no air bubbles in the expended sample.	Notes: Look through the larger opening on the top of the test cartridge. The system will normally catch and flag this failure mode as an air leak (see Test Terminated Due to Air Leak below).
A sample has a platelet dysfunction and a low viscosity, so the volume capacity (syringe travel) of the system is reached before the maximum test time expires.	To determine if this is the cause, run a self-test of the system through the Maintenance menu to verify that there are no system vacuum leaks, then run a second test on the sample from the same subject.	If no errors are reported by the self-test diagnostic and the same result occurs on the replicate test, then this sample probably has a platelet dysfunction. If the replicate test yields a valid result, then the problem was probably caused by a defective test cartridge which caused a small vacuum leak.
Dirt or debris on vacuum seal between instrument and test cartridge, causing a small vacuum leak.	Change O-ring on the vacuum chuck.	From the Maintenance menu, run “Cleaning O-ring” before taking action.

Test Terminated Due to Air Leak (Status Message)

An air leak was detected in the system during the course of the current test. If this was the first of two samples being tested, the system will proceed to test the second sample as normal. To diagnose the cause of the error, start by inspecting the test cartridge on which the status occurred to determine a possible cause.

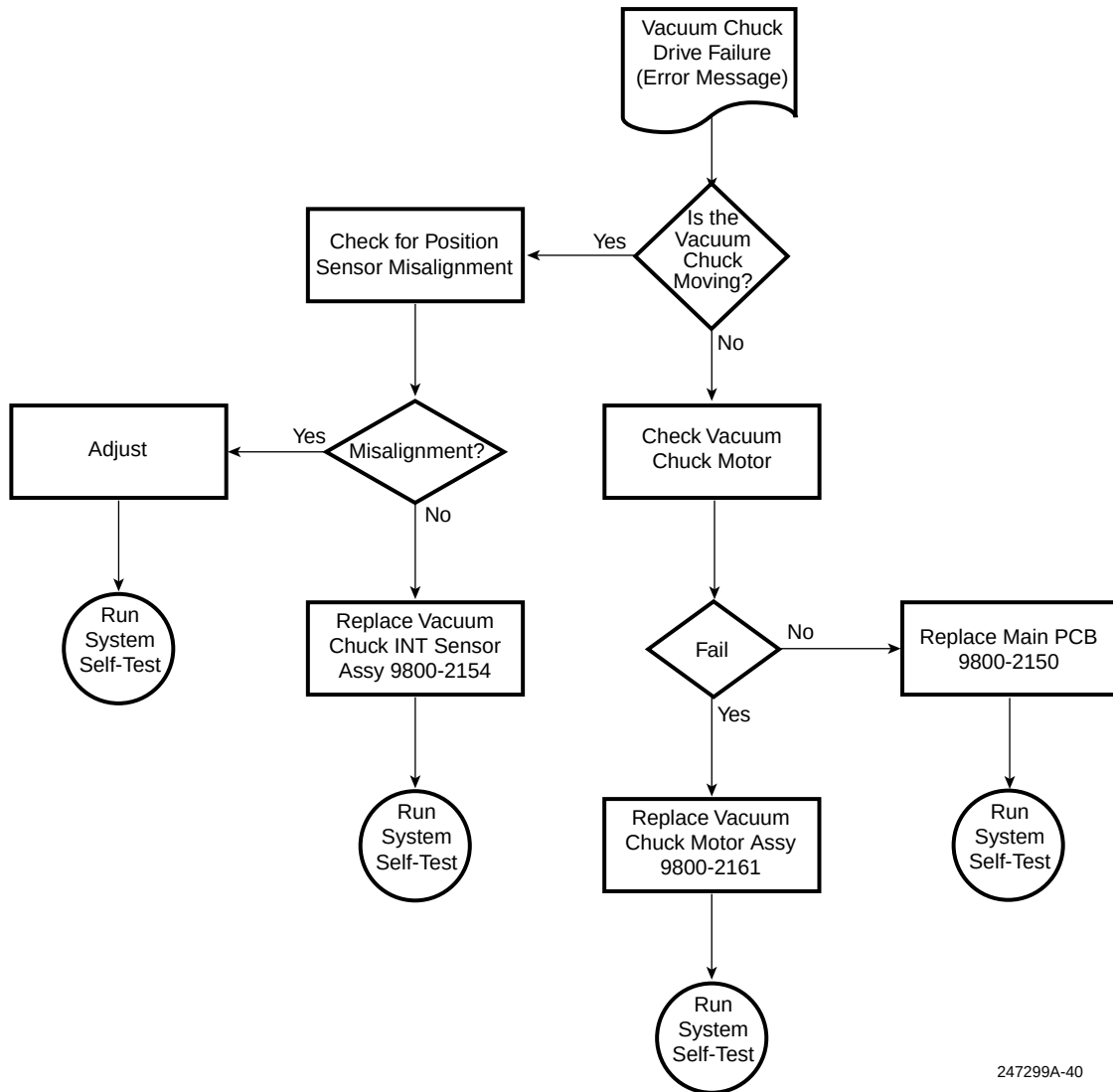
Possible Cause	Solution	Comments or Procedure Used
Insufficient sample in test cartridge	See Operator's Manual.	If this occurs, a larger sample volume should be used when the test is repeated.
Defective test cartridge	Use new test cartridge.	If the system passes the self-test, then the status was most likely caused by a defective test cartridge.
Leak in vacuum system within the instrument	Make sure all the tubing and connectors are properly installed and tightened.	Replacing Vacuum Tubing and Fittings.

Vacuum Chuck Drive Failure (Error Message)

The system detects a problem in the movement of the vacuum chuck drive. This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved.

Possible Cause	Solution	Comments or Procedure Used
A test was attempted on an empty test cartridge housing (like that provided for priming the system)	Use the right test cartridge.	One-slot type is for collagen/EPL. Two-slot type is for collagen/APP. Three-slot type is for Calibration Cartridge. No-slot type is for priming cartridge.
Defective vacuum chuck drive stepper motor	Replace the step motor assembly.	Replacing the Vacuum Chuck Motor
Defective stepper motor drive electronics (located on main board)	Replace Main PCB. After replacing PCB, calibrate AIL, TC and pressure set points.	Replacing the Main PC Board Bracket Assembly in Section 5.
Defective upper or lower position sensor	Replace Interrupter (INT) sensor assembly.	Replacing Vacuum Chuck Interrupter Sensor Assembly
Defective type code sensor (system may attempt to test an empty well)	Replace type code sensor assembly.	Replacing and Aligning Type Code Sensor and Dispense Tube in Section 4.

(Troubleshooting diagram on next page.)



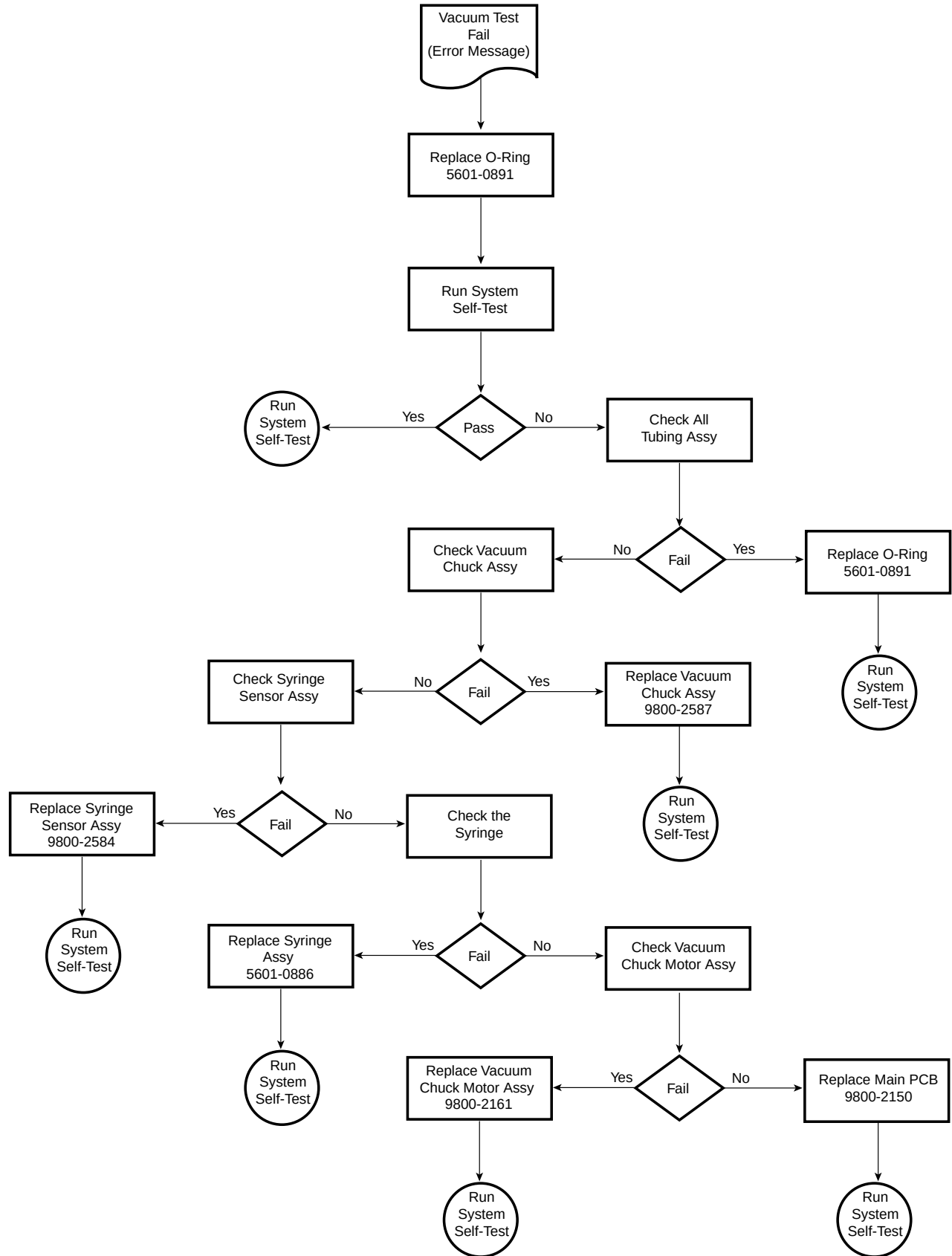
247299A-40

Vacuum Test Failed (Error Message)

The system detects a leak in the vacuum system during the performance of the self-test function initiated from the maintenance menu.

Possible Cause	Solution	Comments or Procedure Used
Dirt or debris is present on the O-ring seal on the vacuum chuck	Clean the o-ring. Replace if necessary.	From the Maintenance menu, run "Cleaning O-Ring" before taking action.
Leak is present in the tubing or fittings	Replace the tubing and fittings.	Replacing Vacuum Tubings and Fittings
Dirty vacuum cup surface	Replace vacuum cup.	—
Defective vacuum sensor/electronics on Main PCB board	Replace Main PC Board.	Refer to Replacing the Main PC Board Bracket Assembly in Section 5.
Defective type code sensor (system may attempt to test an empty well)	Replace type code sensor.	Replacing and Aligning Type Code Sensor and Dispense Tube in Section 4.

(Troubleshooting diagram on next page.)



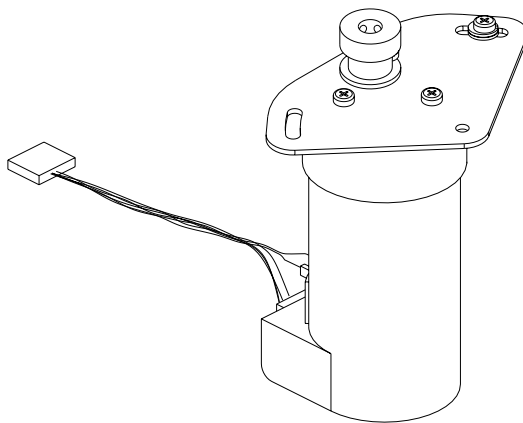
247299A-41

Replacement Procedures

Warning! *Make sure instrument power is OFF before replacing these assemblies.*

Replacing the Syringe Pump Motor (P/N 9800-2633)

Figure 3-2. Syringe Pump Motor

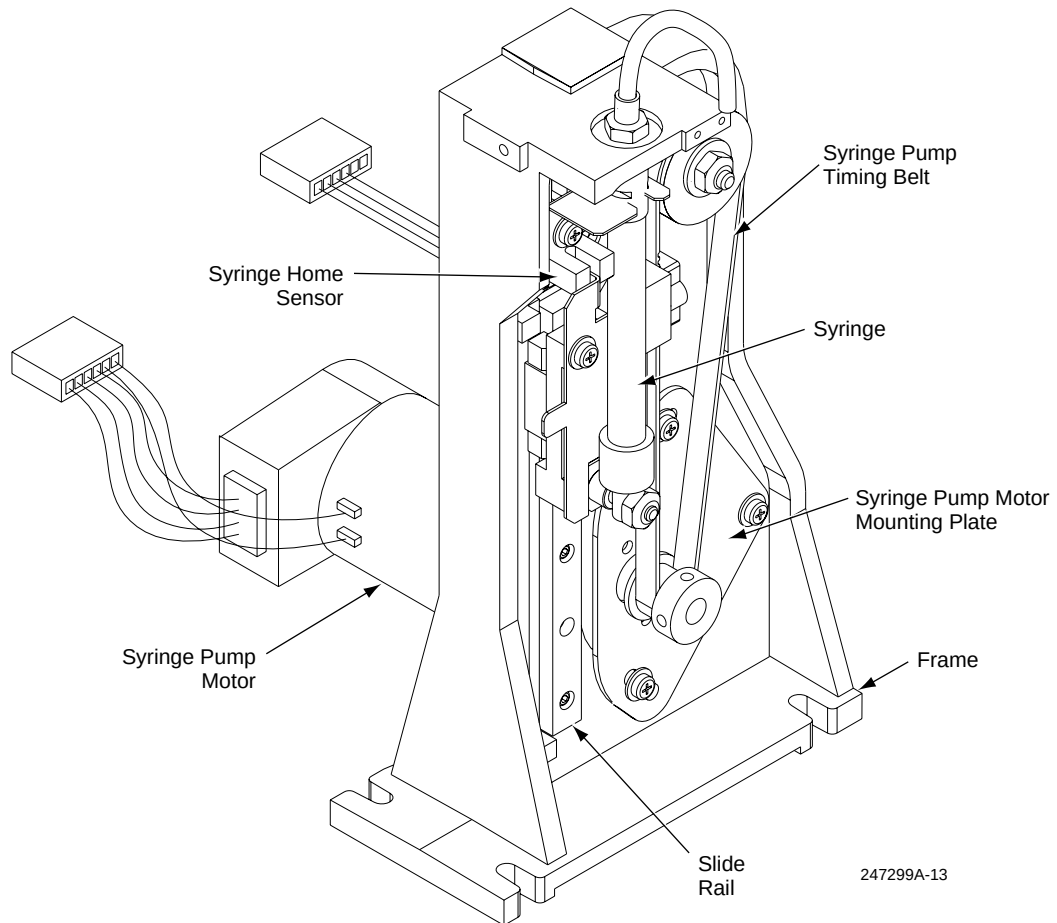


247299A-12

1. To remove the syringe pump motor, loosen the assembled frame on the chassis (3 screws) and remove connectors from the syringe home sensor and syringe pump motor.
2. Loosen motor mounting plate.
3. Take timing belt off motor pulleys.
4. Remove old motor assembly from assembled frame.

(Procedure continued on next page.)

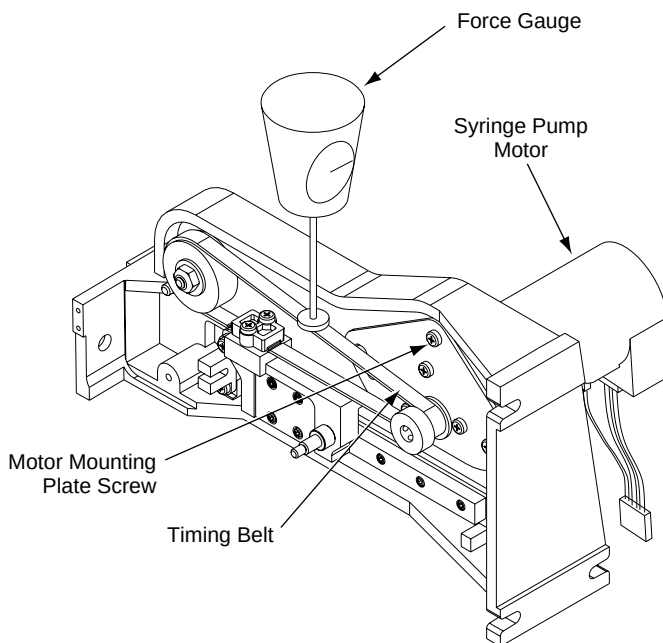
Figure 3-3. Replacing the Syringe Pump Motor



5. Attach new motor assembly (P/N 9800-2633) to assembled frame. Loosely tighten screws to allow motor to pivot.
6. Install syringe pump timing belt (P/N 5601-0848) over pulleys.
7. Tighten timing belt by twisting assembled motor and tightening motor mounting plate screws.
8. Check belt tension with force gauge. Apply 2 ounces of force to center of belt span. Ensure that belt deflection is 0.07 ± 0.02 inches. If deflection is not within tolerance, loosen plate screw and readjust tension until deflection is within tolerance.

(Procedure continued on next page.)

Figure 3-4. Checking Belt Tension



247299A-14

9. Tighten motor mount plate screws.
10. Tighten assembled frame to chassis.
11. Connect motor and home sensor connectors to Main PC board.

Replacing the Syringe Sensor Assembly (P/N 9800-2584)

1. Lower the syringe plunger down to the end (refer to Figure 3-3).
2. Disconnect the sensor wire connector to the main PCB.
3. Remove the two mounting screws attaching sensor assembly to the frame.
4. Install the new sensor assembly with the mounting screws.
5. Attach the connector to the main PCB.

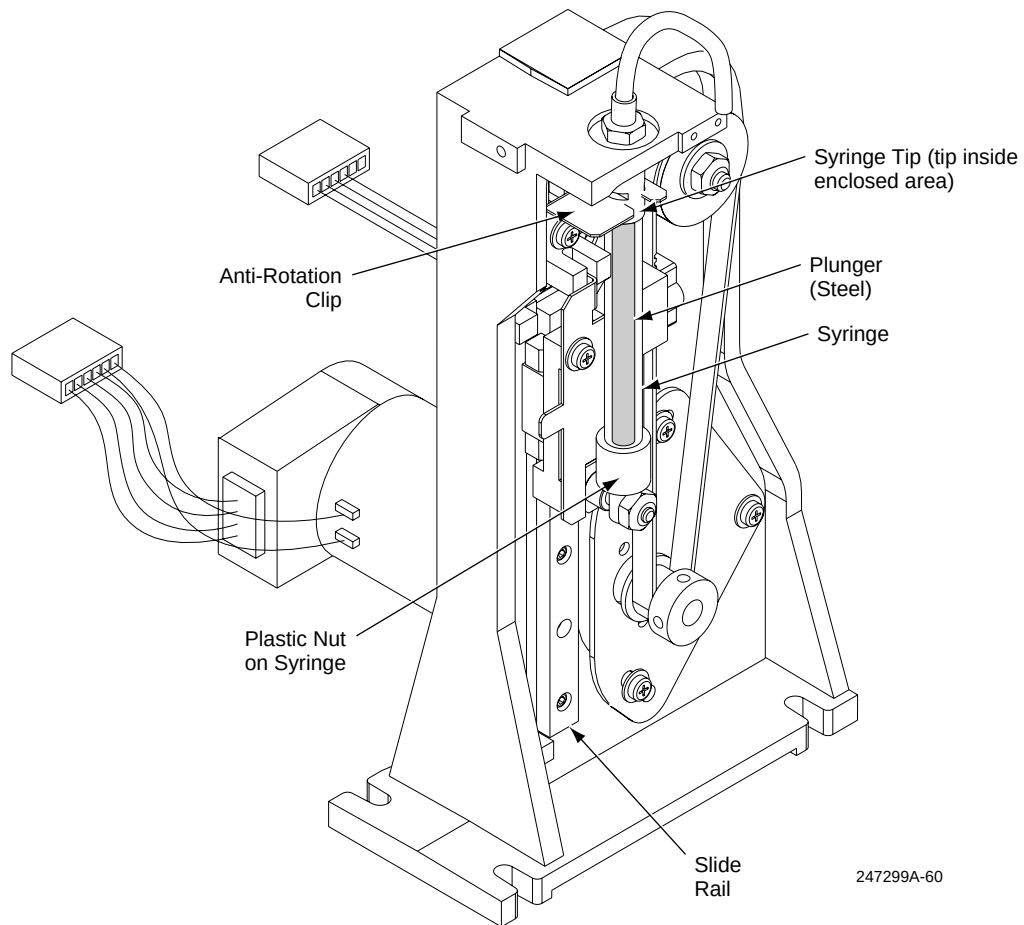
Replacing and Lubricating the Syringe Tip (P/N 5601-0972)

1. Remove the syringe from the syringe pump assembly by removing the lower and upper mounting nuts (5/16" open-end wrench) along with the screw on the anti-rotation clip. Refer to Figure 3-5.
Note: Lowering the syringe plunger down will help remove the syringe.
2. Unscrew the plastic nut on the syringe and remove the plunger from the glass body.

(Procedure continued on next page.)

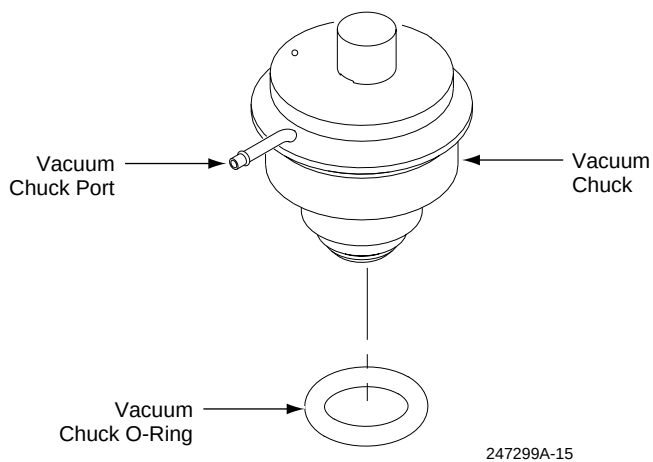
3. Using pliers, carefully remove the black syringe tip and discard.
4. Using deionized water, thoroughly rinse and dry all syringe components.
5. Place the new syringe tip on a flat surface so that the tip mount is facing up. Hold plunger vertically over tip and insert the plunger over the end of syringe tip, using caution not to damage the sealing surface of the tip.
6. Remove the silicon oil (GE Co. PN SF-1000) from the service kit (PN 9009-0298). Place one drop of silicon oil on the side of the syringe tip to ensure that the entire surface of the tip is lubricated.
7. Reassemble the syringe and install it on the pump assembly.

Figure 3-5. Replacing and Lubricating the Syringe Tip



Replacing the Vacuum Chuck Assembly (P/N 9800-2587)

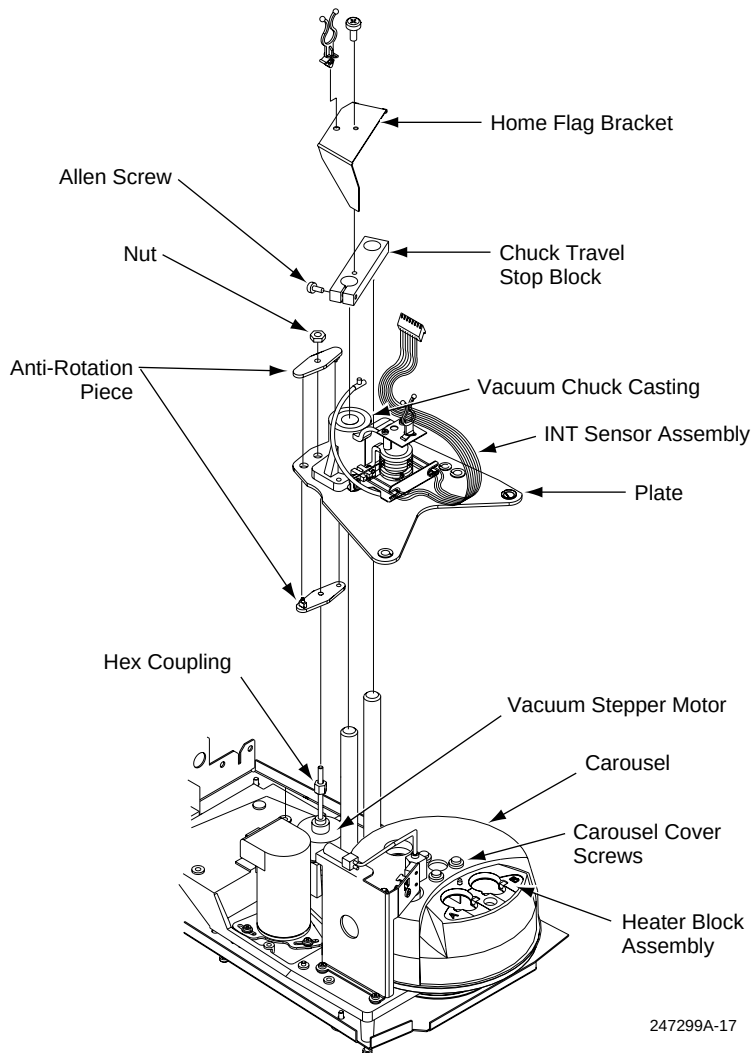
Figure 3-6. Vacuum Chuck



1. Remove the home flag sensor bracket (refer to Figure 3-7).
 2. Remove the chuck travel stop block by loosening the 7/64" Allen screw.
 3. Remove the hex nut on the anti-rotation piece. Use caution not to bend the lead screw.
- Note:** Use open-end wrench (5/16") to hold hex coupling while removing the hex nut with 5/16" nut driver.
4. Take the Microline tubing off the vacuum chuck. Discard tubing.
 5. Remove the vacuum chuck casting by loosening the 4 screws.
 6. Take off the old vacuum chuck.

(Procedure continued on next page.)

Figure 3-7. Replacing Vacuum Chuck



7. Install the new vacuum chuck on the casting.
8. Secure the new 7-inch (P/N 5601-0916) Microline tubing to the vacuum port on the chuck.

Caution: No tubing can be cut shorter or reused. Reused tubing can cause leaking. Tubing length has effect on trigger solution volume.

9. Reinstall the vacuum chuck casting (4 screws).
10. Reinstall the plastic anti-rotation piece and locking nut.

Note: Use open-end wrench (5/16") to hold hex coupling while tightening the hex nut with 5/16" nut driver.

11. Reinstall the chuck travel stop block and secure it with the Allen screw.

12. Reinstall the home flag to the top of the chuck travel stop block.

Replacing the Vacuum Chuck Interrupter (INT) Sensor Assembly (PN 9800-2154)

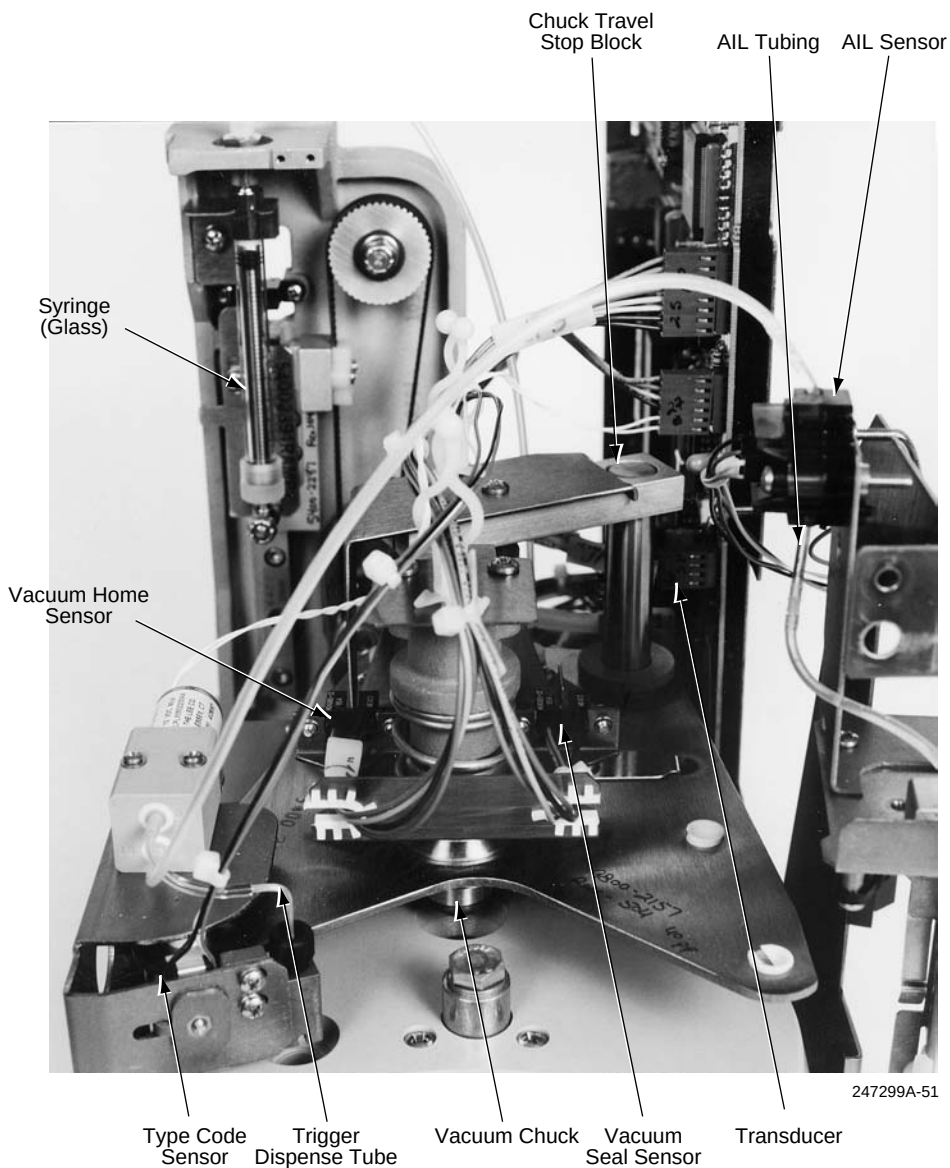
1. Unplug the connector to the Main PC board.
2. Remove the mounting screws to both sensors (vacuum home sensor and vacuum seal sensor).

Figure 3-8. Replacing Vacuum Chuck INT Sensor Assembly

Trigger Dispense System: Bottle, AIL Sensor/Tubing, Solenoid Pump, Dispense Tube and Type Code Sensor

Vacuum Control System: Syringe Pump Motor, Syringe, Transducer, Vacuum Chuck, Sensors

Note: Vacuum Home Sensor and Vacuum Seal Sensor make up the INT Sensor Assembly.

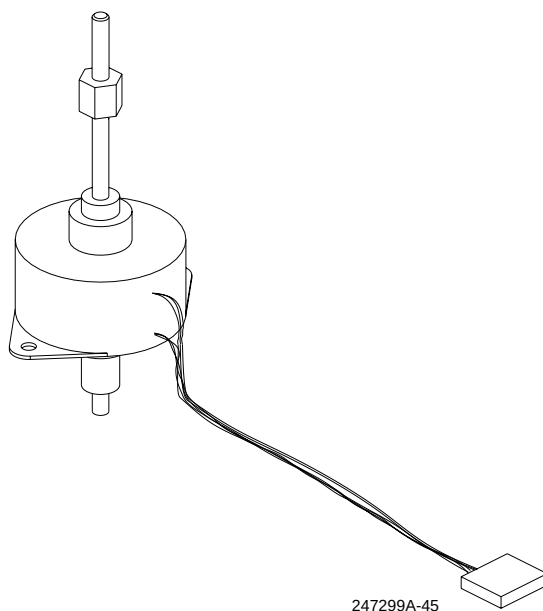


(Procedure continued on next page.)

3. Remove the sensor assembly.
4. Install the new assembly.
5. Plug in the connector to the main PC board.
6. Power-up the instrument. From the hidden menu, select "6" Chuck Test.
7. From the chuck position test printout, verify the following:
 Home steps=0
 Park steps are less than 1590.

Replacing the Vacuum Chuck Motor Assembly (P/N 9800-2161)

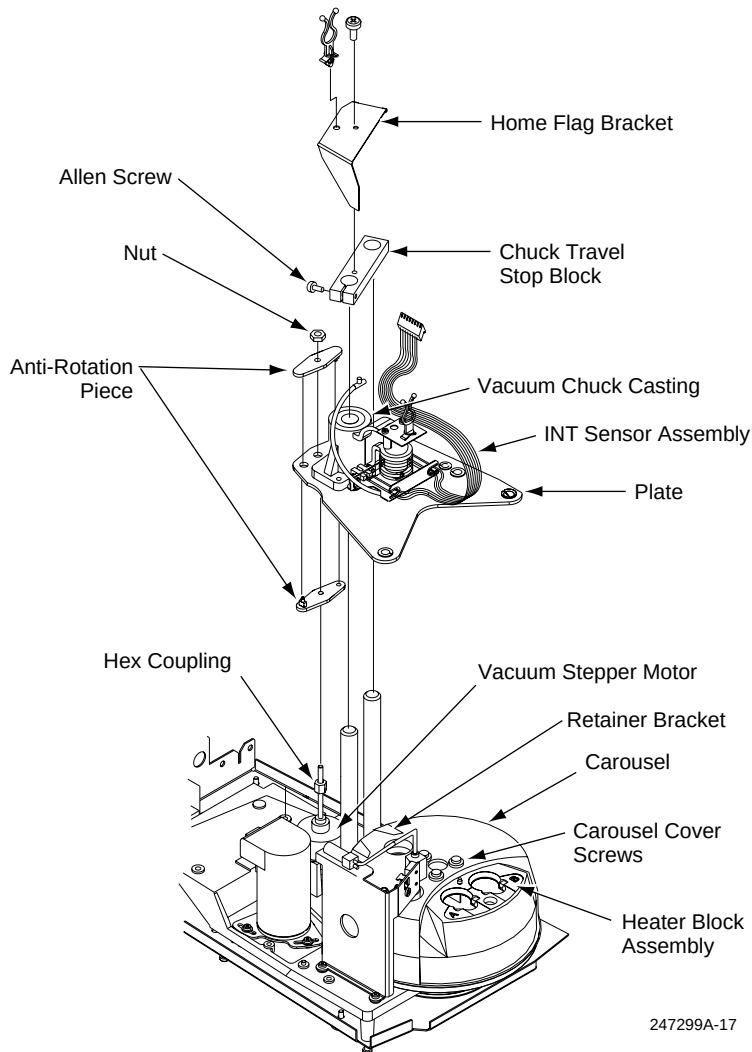
Figure 3-9. Vacuum Chuck Motor with Motor End Fitting (P/N 5400-2372)



1. Bond the new vacuum chuck motor and end fitting using Loctite[®] primer N764 to the tip of the motor shaft and fitting hole.
2. Remove the home flag sensor bracket (refer to Figure 3-10).
3. Remove the chuck travel stop block by loosening the Allen screw.
4. Use open-end wrench (5/16") to hold hex coupling and remove the hex nut on the anti-rotation piece. Use caution not to bend the lead screw.
5. Take the Microline tubing off the vacuum chuck. Discard tubing.
6. Remove the vacuum chuck casting by loosening the 4 screws.

(Procedure continued on next page.)

Figure 3-10. Replacing Vacuum Chuck Motor



6. Lift plate off vertical shafts.
7. Disconnect vacuum chuck motor cable from main PC board.
8. Loosen the 2 screws that secure the retainer bracket to the chuck motor. Remove the vacuum chuck motor.
9. Reverse the steps above to install a new stepper motor.

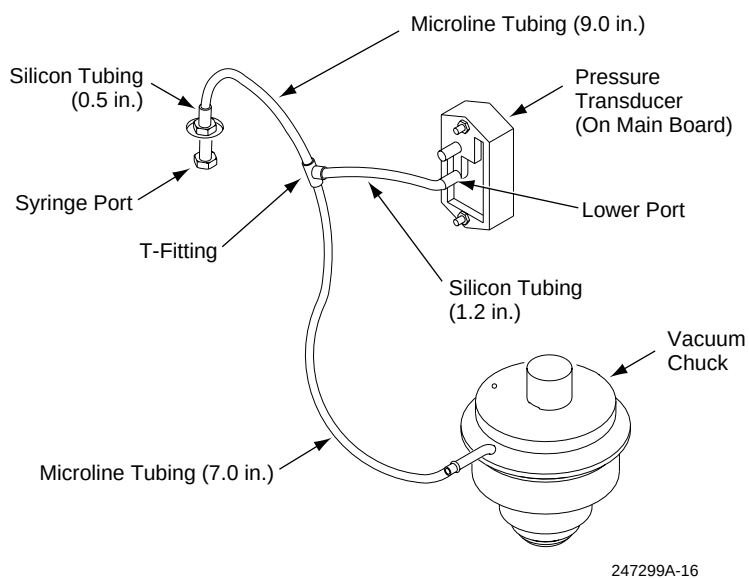
Note: Before tightening the two mounting screws, adjust the position of the retainer bracket so it is within 1/32" of the carousel—this will prevent the carousel from touching the retainer bracket when it rotates.

Note: When reversing steps for reinstallation, use PN 5601-0916 to replace the Microline tubing.

Replacing Vacuum Tubings and Fittings

1. Disconnect the old tubing from the vacuum chuck and pressure transducer (on main PCB).
2. Remove the silicon tubing and disconnect the old tubing from syringe.

Figure 3-11. Vacuum Tubings and Fittings



3. Locate the tubing and fittings in the spare part list, and cut the length and quantity specified as follows.

Item #	P/N	Description	Length/Qty.
1	5601-0970	Conn. T fitting 1/16 -1/8	1 ea
2	5601-0916	Tubing, Microline 0.05 ID	7.0 in.
3	5601-0916	Tubing, Microline 0.05 ID	0 in.
4	5601-0971	Tubing, silicon, 3/32 ID	1.2 in.
5	5601-0971	Tubing, Silicon, 3/32 ID	5 in.

4. Connect all the tubing and fittings (refer to Figure 3-11).

Note: Follow natural flow of tubing to prevent kinking.

(Procedure continued on next page.)

5. Insert one end of connector to the end of tubing that connects to the vacuum port on the vacuum chuck.
6. Insert the other end of the connector into the 9-inch Microline tubing.
7. Slip the other end of the 9-inch tubing into the 0.5-inch silicon tubing and secure the Microline tubing at the top of the syringe. Slide the 0.5-inch silicon tubing down over the syringe fitting and Microline tubing.

Caution: To avoid damaging the instrument, do not kink the tubing.

8. Insert the large barb of the T-connector into the other 1.2-inch silicon tubing.
9. Insert the other end of the 1.2- inch silicon tubing onto the **lower port** of the pressure transducer on the main PCB.

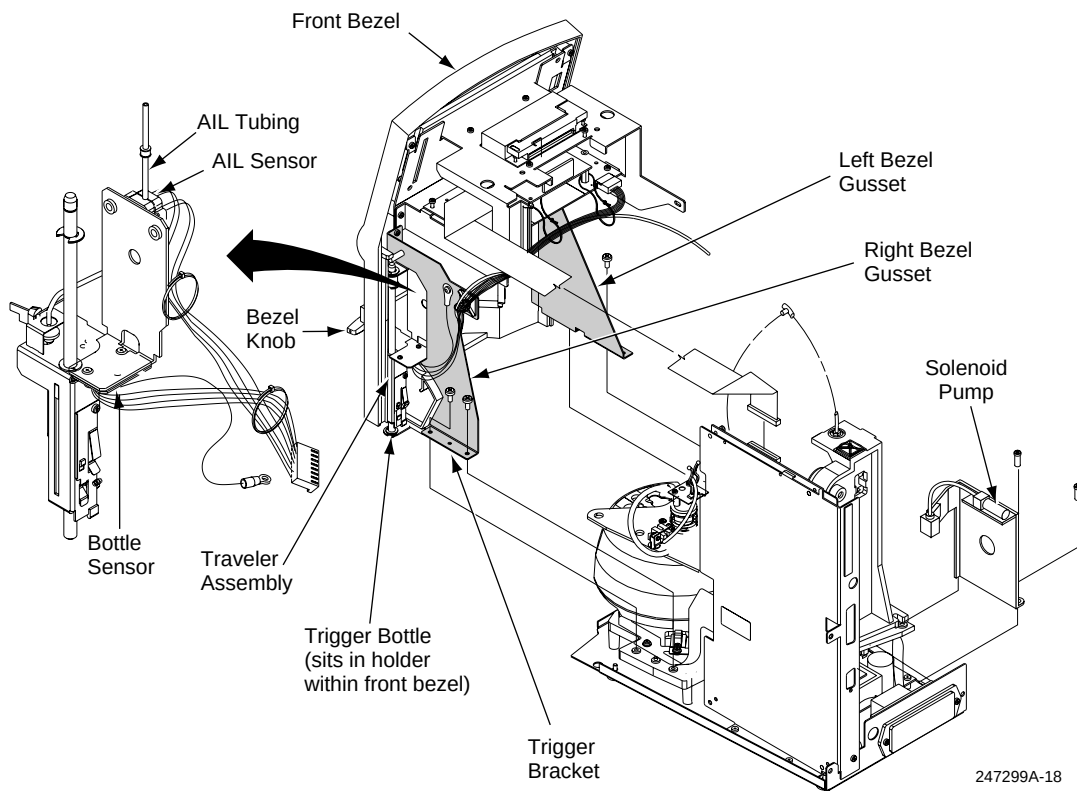
Section 4: Trigger Solution Dispense System

System Components

Components of the trigger solution system include:

- trigger bottle traveler assembly (includes AIL sensor and bottle sensor)
- solenoid pump
- tubing and fittings

Figure 4-1. Trigger Solution Dispense System Components



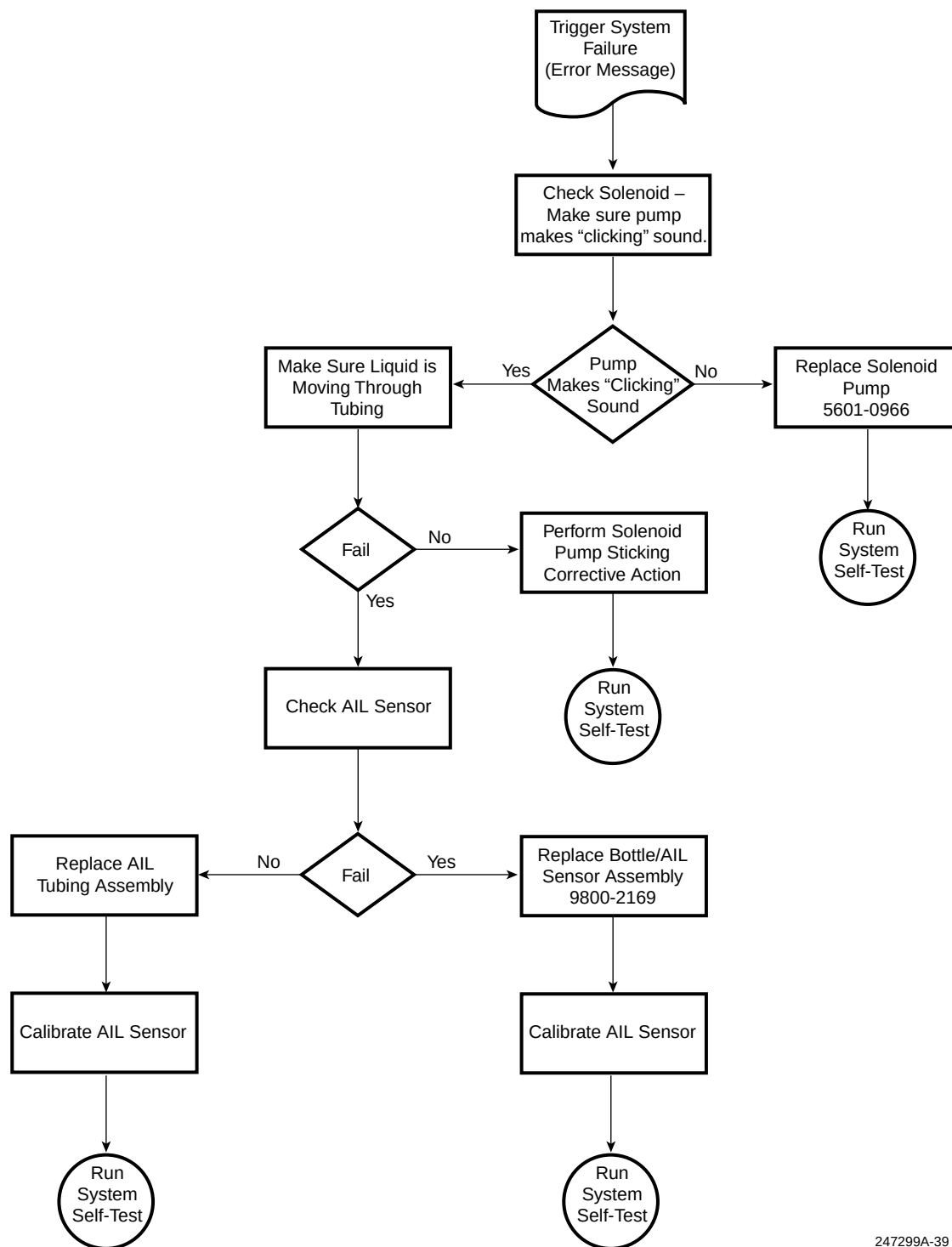
Error Messages and Causes

Trigger System Failure

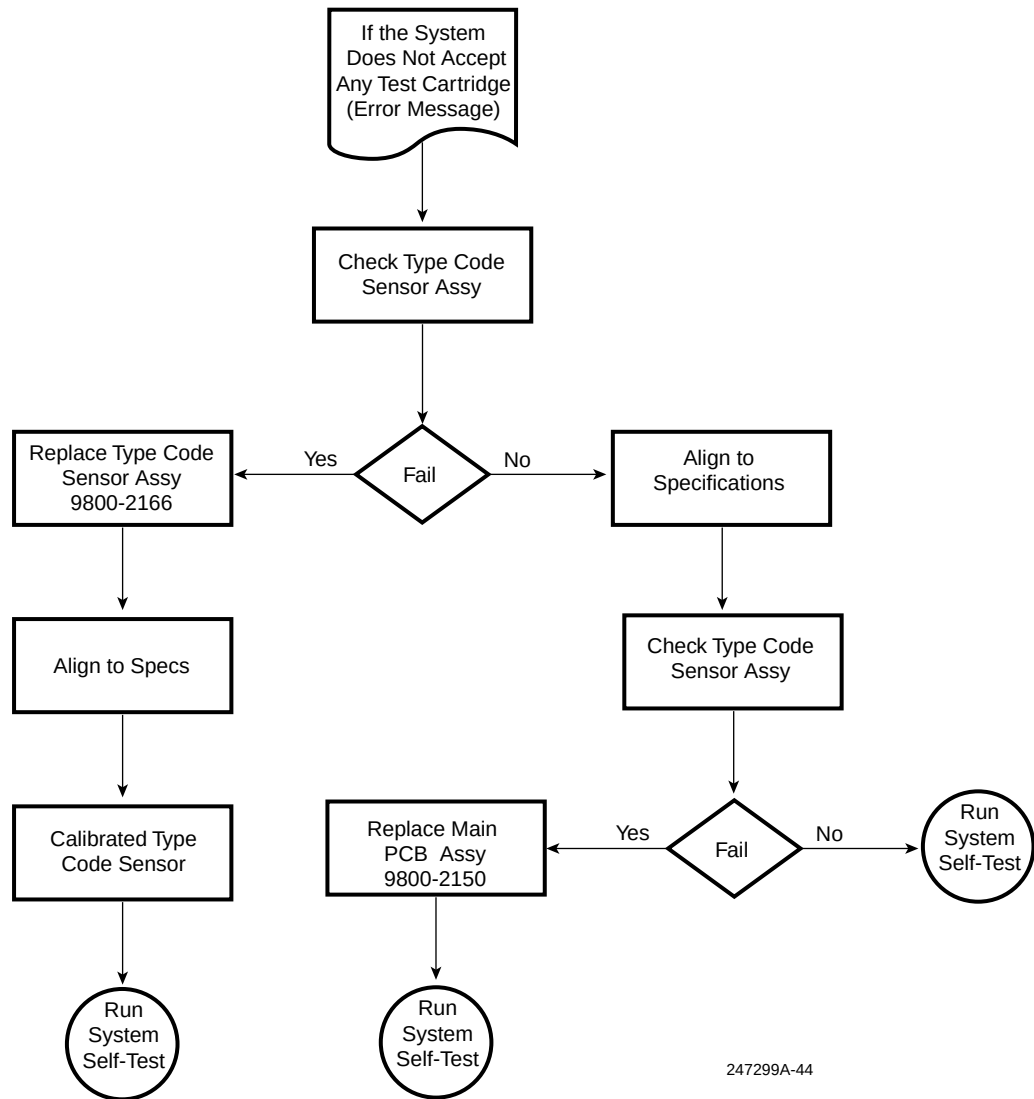
The system continues to detect air in the trigger solution lines after three successive attempts to prime the system (followed by the message “Air Detected in System”). Trigger system failure will occur if the operator continues to prime the system without replacing the empty trigger bottle. This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved. If this error continues to occur after the operator has verified that a full trigger bottle has been loaded into the system, then check the following:

Possible Cause	Solution	Comments or Procedure Used
AIL sensor has failed.	Replace AIL sensor.	Replacing AIL Sensor
There is a leak in the trigger bottle spiking needle, tubing or tubing connections.	Replace needle or tubing.	Replacing AIL Tubing
Air-in-Line (AIL) tubing is kinked.	Replace tubing.	Replacing AIL Tubing
Self-priming solenoid pump is sticking.	Check pump.	Solenoid Pump Sticking Corrective Action

(Troubleshooting diagrams on next pages.)



247299A-39



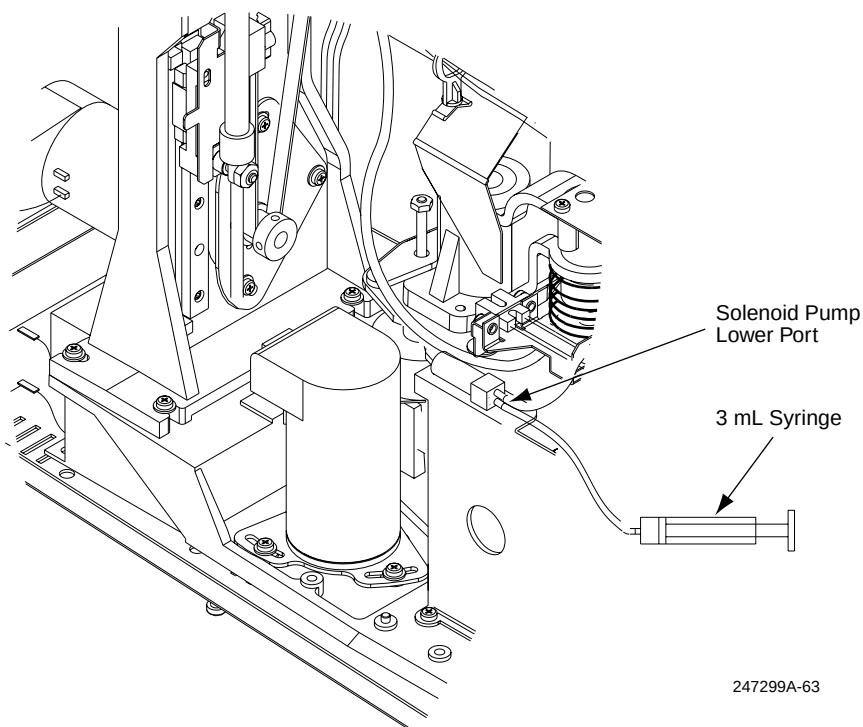
247299A-44

Solenoid Pump Sticking Corrective Action

1. Turn the power off and open PFA cover.
2. Locate the solenoid pump, mounted on a bracket at the left bezel gusset of the analyzer. The pump has two ports, one on top of the other. The top port is connected to the dispense nozzle and the lower is connected to the trigger bottle.

Warning: *Make sure you do not disturb the pump bracket alignment, which defines the dispense tube location. Misalignment could result in inaccurate results.*

3. Remove left bezel gusset to gain access to solenoid pump.
4. Carefully remove the tubing that connects the solenoid pump to the trigger bottle.
5. Load the 3-mL syringe with DI water and connect the silicone tubing (attached to syringe) to the lower port on the pump.



(Procedure continued on next page.)

6. Place the trigger bottle, blue priming cartridge, on the analyzer and turn the power on.

Caution: Do not spill the DI water inside the instrument; damage could occur.

7. When the Read System screen is displayed, press the key next to the [Menu].
8. Press “2” Maintenance, then “4” Prime.
9. After the first pump click, press very gently on the 3-mL plunger while the pump is clicking. Observe that fluid is dispensed into the blue priming cartridge.
10. After the tenth click, “Trigger Bottle Empty Please Load New Trigger Bottle” is displayed. Press Continue and repeat step 8 until message disappears.
11. Disconnect the silicone tubing and the 3-mL syringe from the analyzer.
12. Connect the original tubing from the trigger bottle to the lower port on the pump.
13. Press Continue and prime the system.

Replacement Procedures

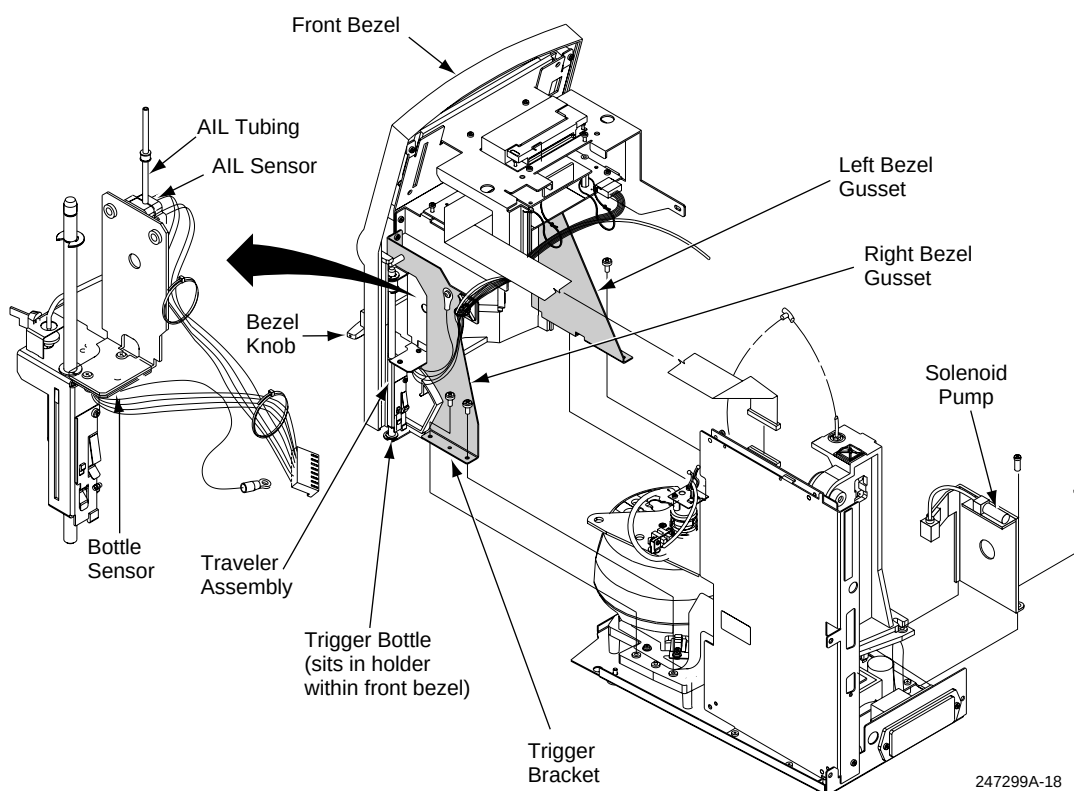
Replacing Trigger Bottle Traveler Assembly (P/N 9800-2170)

Figure 4-2. Trigger Bottle Traveler Assembly



(Procedure continued on next page.)

Figure 4-3. Replacing the Trigger Bottle Traveler Assembly

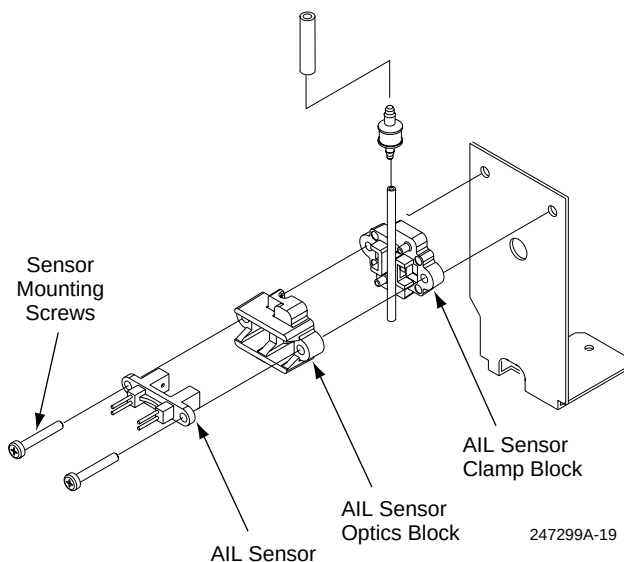


1. Remove the trigger bottle from the holder.
2. Disconnect the display cable that attaches to the interface board. Disconnect the bottle assembly connector from the main PCB.
3. Remove 2 screws on right bezel gusset attached to chassis.
4. Remove 4 screws attaching display to front bezel and 2 screws that attach left bezel gusset to front bezel.
5. Take the knob off the front bezel by loosening the Allen screw using .050 Allen wrench. Push the end of the traveler shaft up so that the shaft is off the baseplate.
6. Carefully detach the front bezel from the instrument.
7. Remove needle tubing and AIL tubing.
8. Remove bottom 2 screws and top 1 screw that attach trigger traveler assembly to front bezel.
9. Detach the trigger bottle assembly from the front bezel.
10. Reverse the order to install the new trigger bottle assembly.

Note: After the new assembly is installed, replace the AIL tubing (refer to procedure in this section).

Replacing the Bottle and AIL Sensor Assembly (P/N 9800-2169)

Figure 4-4. AIL Sensor



Note: The bottle sensor and AIL sensor are located at different areas on the instrument. To replace the assembly, first remove the trigger bottle traveler assembly from the instrument as described in the previous procedure. Then perform the following steps:

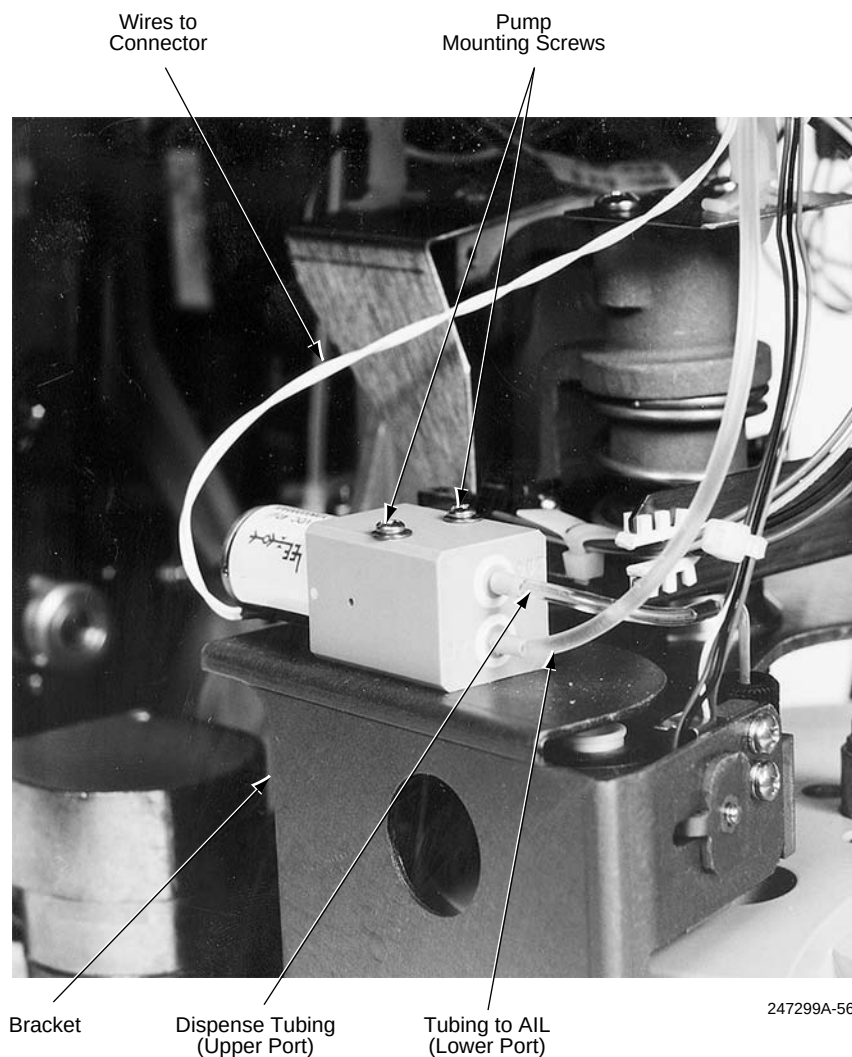
1. Disconnect the tubing on both ends of the sensor.
2. Take the AIL sensor off the bracket (2 screws) and remove the bottle sensor from the underneath the platform of the traveler assembly.
3. Clean the optics block using Isopropanol solution.
4. Install new AIL tubing (P/N 5601-0934) in the sensor blocks (P/N 5400-2354).

Note: The AIL tubing must be cut to 2.0 inches (50.1 mm).

5. Attach the new assembly using the original screws to the bracket and platform.
6. Attach traveler assembly to the instrument.

Replacing the Self-Priming Solenoid Pump (P/N 5601-0966)

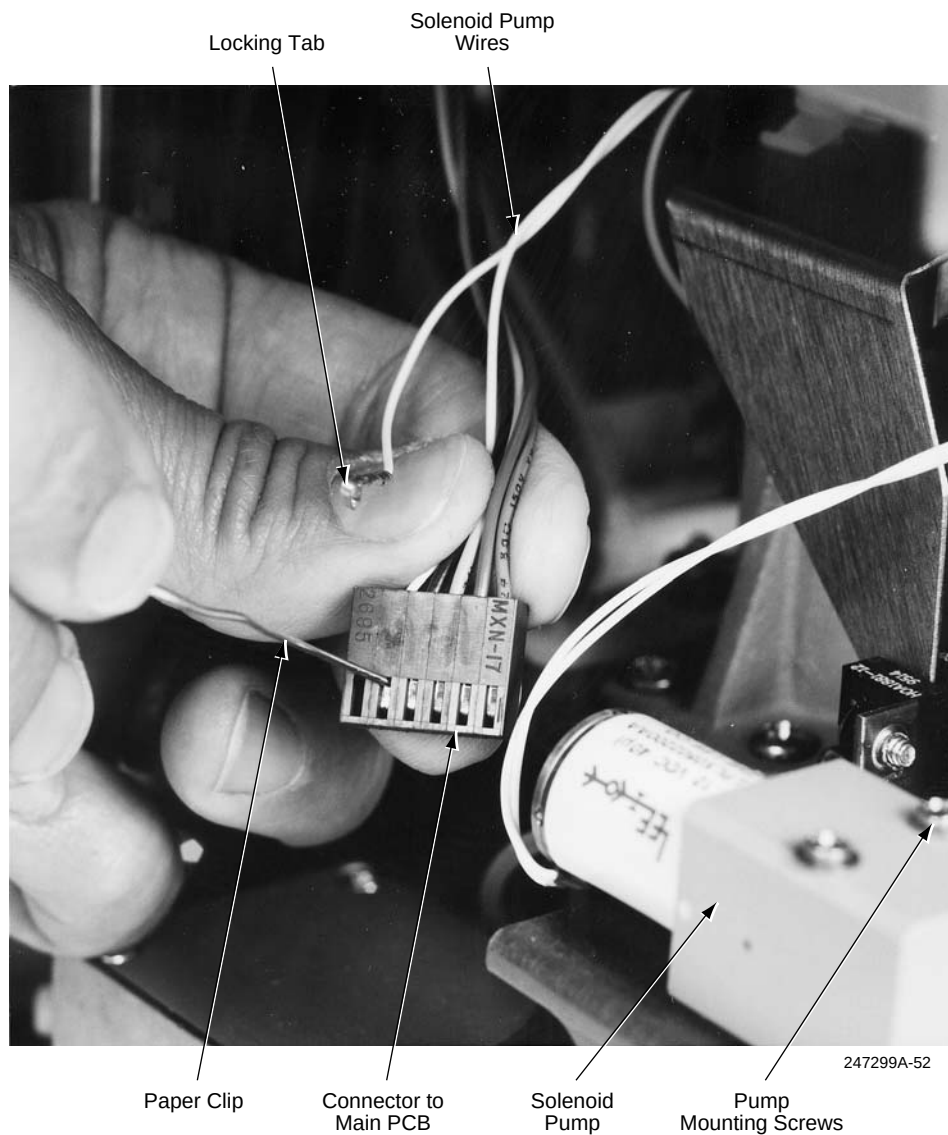
Figure 4-5. Solenoid Pump



1. Disconnect the tubing from the top and bottom solenoid pump ports.
2. Disconnect connector between pump wires and main PC board.
3. Using a paper clip, press the locktab on the connector to release the pump wires (see Figure 4-6.)
4. Remove the 2 mounting screws from the pump.
5. Take off the old pump from the bracket.
6. Attach the new pump using the screws. Make sure “OUT” port is positioned as the upper port.

(Procedure continued on next page.)

Figure 4-6. Pressing Locktab to Release Pump Wires

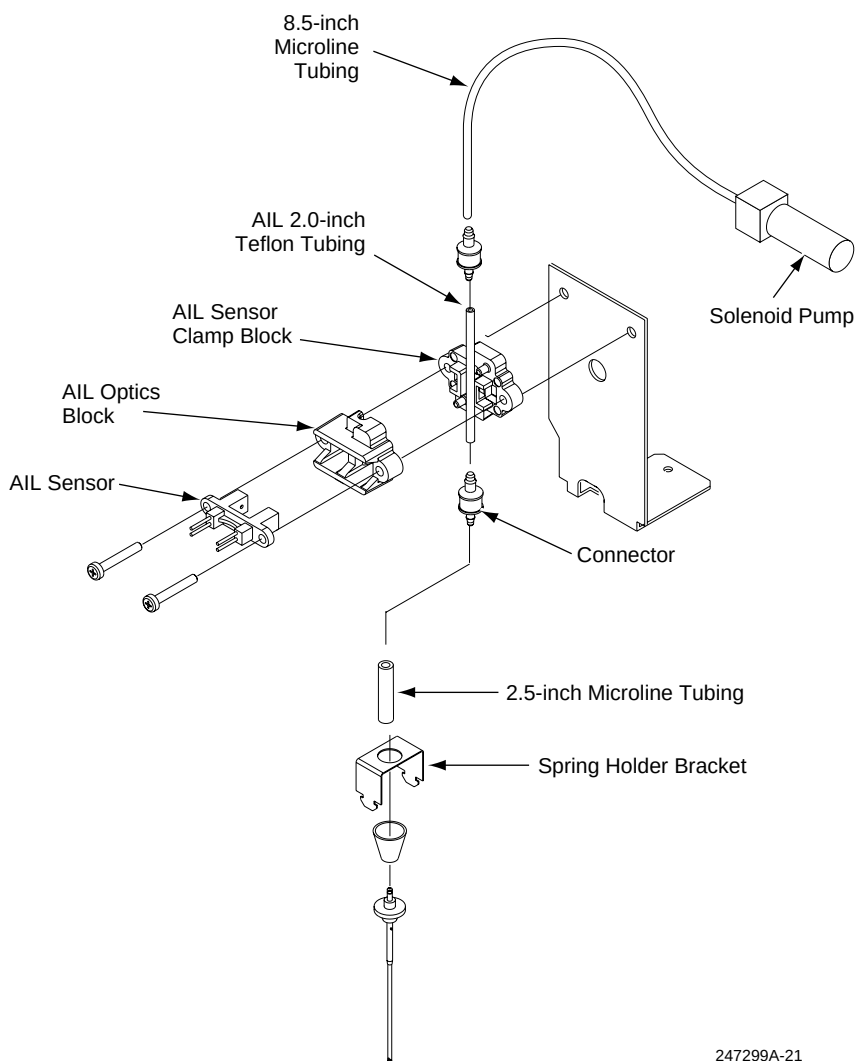


7. Connect the tubing on both ports. Tubing from AIL goes to the “IN” (lower) port. Tubing connected to dispense tube goes to “OUT” (upper) port.
8. Attach the wires to connector.
9. Reconnect the connector to the main PC board.

Replacing the AIL Tubing

1. Disconnect tubing attached to solenoid pump (lower port).
2. Use two fingers to squeeze and detach the spring holder bracket from the original position (lowered).

Figure 4-7. Replacing AIL Tubing



3. Disconnect the needle tubing from needle and discard tubing.
4. Remove 2 screws on AIL sensor.
5. Open AIL sensor and remove the old tubing.

(Procedure continued on next page.)

6. Locate the tubing and fittings in the spare part list, with length specified as follows:

Item	P/N	Description	Qty/Length
5601-0919		Conn, Tube, 1/16"	2 ea.
5601-0934		AIL Tubing, Teflon® FEP, 0.063 ID	2.0 in.
5601-0916		Tubing, Microline, 0.05 ID	2.5 in.
5601-0916		Tubing, Microline, 0.05 ID	8.5 in.

7. Connect all the tubing and fittings as shown in Figure 4-7.

Cautions: No tubing can be cut shorter or reused. Reused tubing can cause leaking. Tubing length has effect on trigger solution volume.

The AIL tubing (5601-0934) will be compressed after clamping. Therefore if AIL blocks were disassembled, new AIL tubing must be installed.

8. Position the 2.0-inch AIL tubing in the AIL sensor so that it is centered in the AIL block and the 2.5-inch Microline tubing exits from the bottom of the AIL sensor.
9. Connect the other end of the tubing to the trigger needle. Ensure a smooth loop with no kinks.
10. Secure the AIL sensor using 2 original screws.
11. Install the spring holder bracket to the original position.
12. Route the 8.5-inch Microline tubing that exits the top of the AIL sensor so that it is on the left side of the right front panel support bracket.
13. Connect the 8.5-inch tubing to the "IN"(lower) port on the solenoid pump.

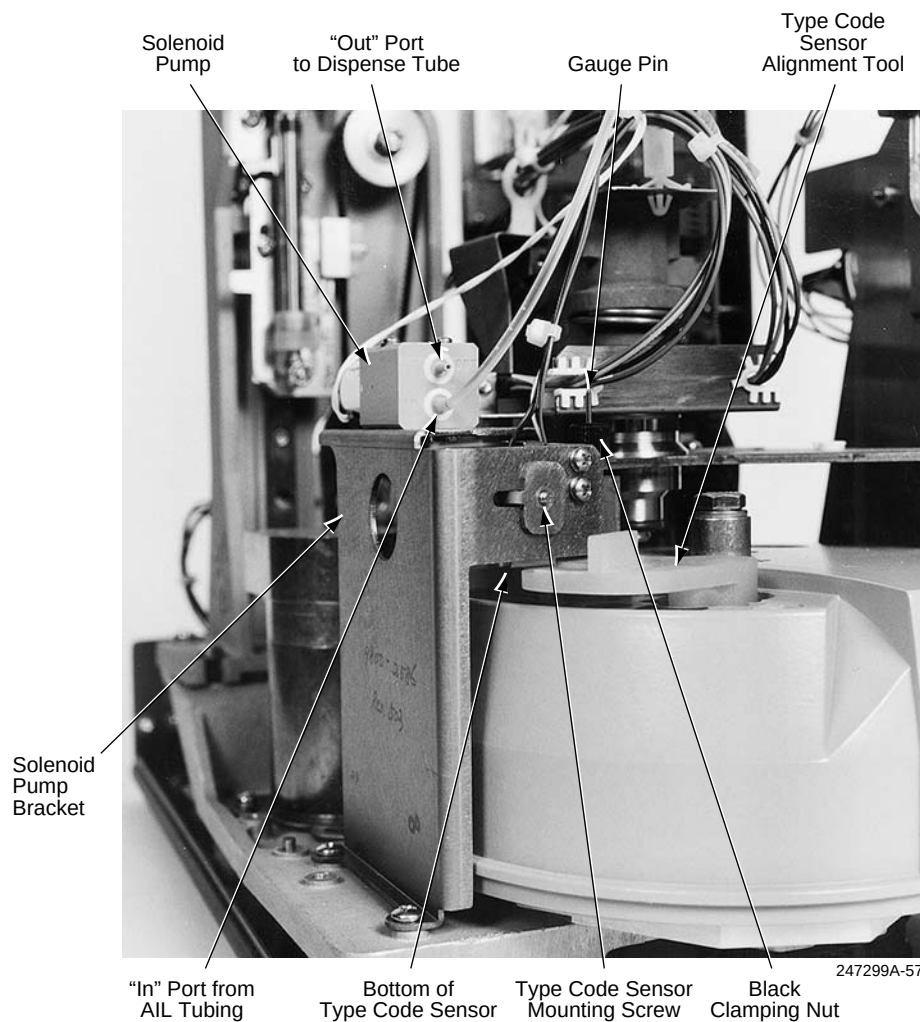
Replacing and Aligning the Type Code Sensor and Trigger Dispense Tube

Replacing the Type Code Sensor (P/N 9800-2166)

1. Locate solenoid pump bracket.
2. Remove 1 screw to detach the type code sensor.
3. Unplug the type code sensor cable on the main PCB.
4. Install the new type code sensor by reversing steps 2 and 3.
5. Align both the type code sensor and trigger dispense tube.

Note: This step *must not* be skipped. Detailed information on how to align the type code sensor and trigger dispense tube are provided on the next pages.

Figure 4-8. Replacing and Aligning the Type Code Sensor and Trigger Dispense Tube



Aligning the Type Code Sensor

1. Check the type code sensor alignment.
 - a. Enter the Hidden Maintenance screen and enter access code “10155.” Select “6” (Calibrate TC). Set the type code adjust bit #13 to “1” and press “Accept.”
 - b. Insert the 3-slot calibration cartridge, press “6” to calibrate, and follow the screen prompts.
2. If the printout results shows “failed,” perform alignment.
 - a. Insert green alignment tool (P/N 9009-0245). Refer to Figure 4-8.
 - b. Loosen the type code sensor mounting screw.
 - c. Gently press the sensor down so that the bottom of the sensor is flush with the top of the alignment tool.

Note: For proper alignment, do not press too hard on type code sensor.

- d. Tighten the mounting screw.
- e. Repeat step 1 to check the alignment.

Aligning the Trigger Dispense Tube

1. Check the dispense tube alignment.
 - a. Run a test with a cartridge (1-slot or 2-slot) in position A and cancel test after incubation begins.
 - b. Remove the cartridge. Check if the droplet is centered on the membrane.
2. If the droplet is not centered on the membrane, perform the alignment.
 - a. Loosen the black clamping nut and remove the dispense tubing (P/N 5601-0866) along with the dispense tube (refer to Figures 4-5 and 4-8).
 - b. Loosen the screw that holds the gray PVC block.
 - c. Insert pin gauge (P/N 9009-0265) into PVC block and hole in the green alignment tool.
 - d. Tighten 2 screws. Remove pin gauge and green alignment tool.
 - e. Reinstall dispense tubing, as well as the dispense tube, and connect to “OUT” (upper) port of solenoid pump.

Warning: *Be careful not damage the tip of the Teflon® tubing on the trigger dispense tube. If the tubing is damaged, the 40 µL of trigger solution will not be dispensed on the center of the test cartridge membrane, which is critical for accurate test results.*

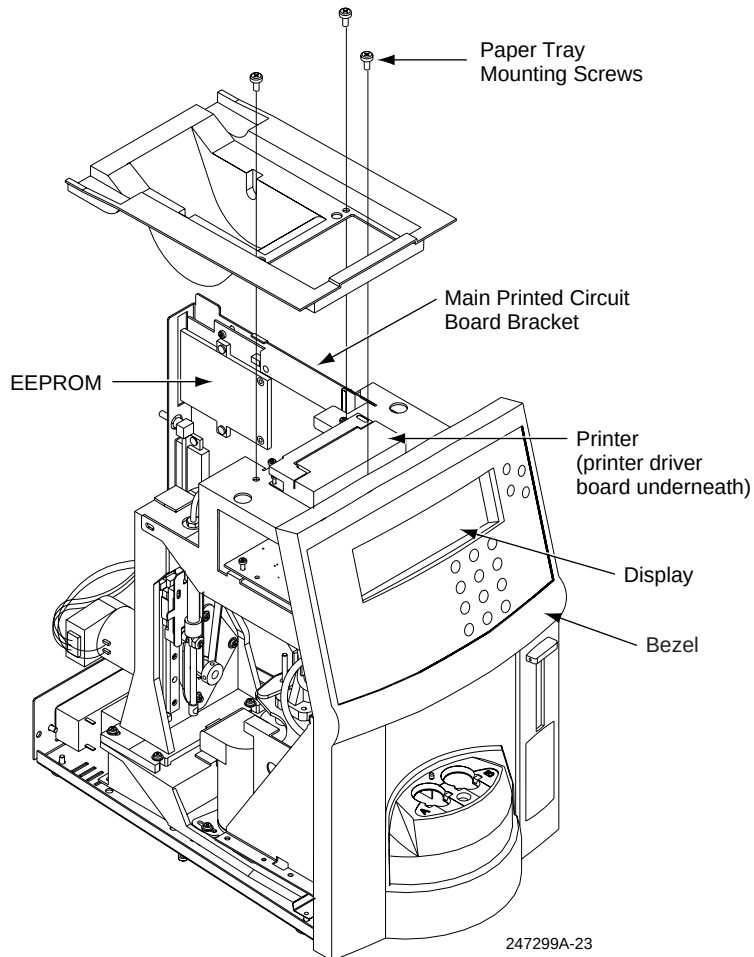
Section 5: Instrument Control System and Power Supply

System Components

Components of the Instrument Control system include:

- display assembly
- printer assembly
- printer driver board assembly
- main PCB bracket assembly

Figure 5-1. Instrument Control System Components



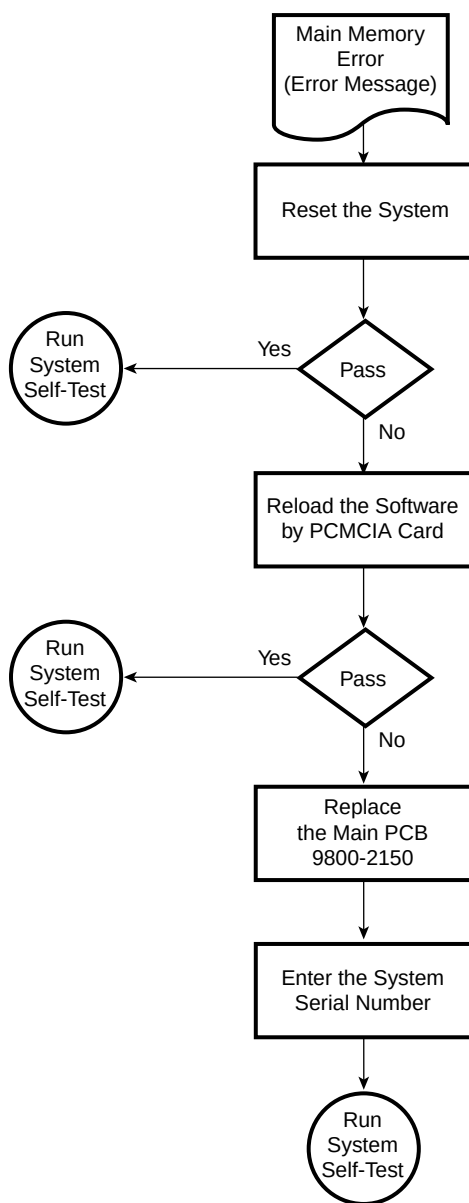
Error Messages and Causes

Main Memory Error

The system detects an error in the system's operating program, which is stored in the main memory. This error message can only be cleared by cycling power to the unit, but the message will reappear if the problem has not been resolved.

Possible Cause	Solution	Comments or Procedure Used
An electronic hardware failure (flash EEPROM on the main board)	Replace the main PC board.	Replacing the PCB Bracket Assembly.
A corruption of the software program	Reload software.	Before reloading software, try resetting the system to see if the error can be cleared.

(Troubleshooting diagram on next page.)



247299A-36

Maximum PID Length Exceeded

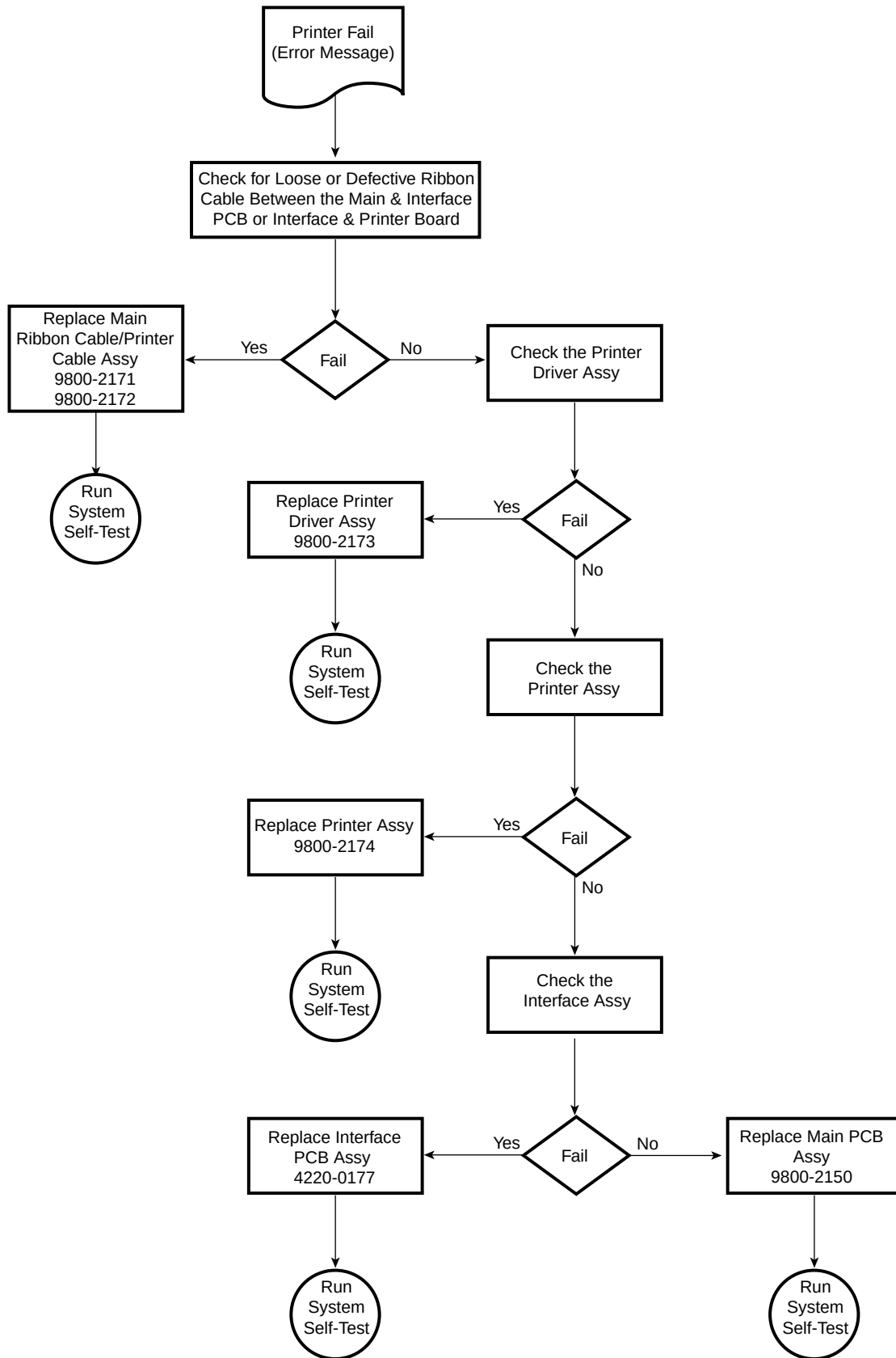
The system detects that the patient ID entered through the bar code reader exceeds the maximum allowable length of 12 characters. Verify that your institution's patient ID bar code standard does not exceed the 12-character limit. If it does, enter an abbreviated ID of 12 or fewer characters with the keypad.

Printer Fail (Error Message)

The system detects that information sent to printer is not processed. This message can only be cleared by cycling power to the system, but the message will reappear the next time the system tries to print if the problem has not been resolved.

Possible Cause	Solution	Comments or Procedure Used
Defective printer or printer driver board	Replace printer assembly or printer driver board.	Replacing Printer Assembly
Defective Main board	Replace Main PC board.	Replacing Main PCB Bracket Assembly
Loose or defective ribbon cable between the main and interface boards or the interface and printer boards	Replace ribbon cable.	Replace 9800-2171 or 9800-2172

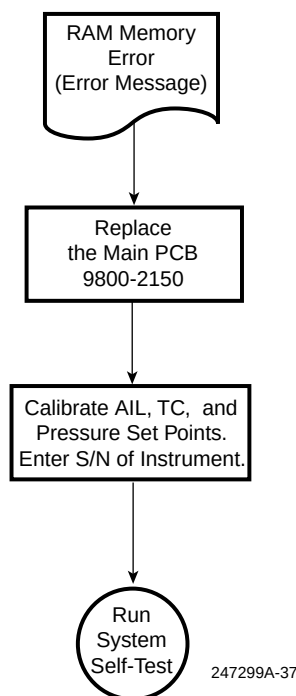
(Troubleshooting diagram on next page.)



247299A-42

RAM Memory Error

The system detects a problem with the area of memory used to store data and system information (located on the Main board). This error message can only be cleared by cycling power to the unit, but will reappear if the problem has not been resolved.



Test Canceled - No Control Number Entered - Press Continue

The user did not enter a patient ID number or test cartridge lot number when requested by the system. The system requires both of these entries before it will complete a test intended to be saved as a Control or QC run. The system allows approximately 2.5 minutes (incubation period) to enter this information. Press “Continue” to return to the System Ready screen.

Maximum Test Time Exceeded

The system detects that the sample did not achieve closure within the maximum allowable time for a test (5 minutes, not including the incubation period). This indicates an abnormal sample. Run a repeat to verify an equivalent result. If this message occurs on known or suspected normal samples, it may indicate a very low-level vacuum leak in the system. Perform a self-test of the system through the Maintenance menu to check for this problem.

Replacement Procedures

Warning! *Make sure instrument power is OFF before replacing these assemblies.*

Replacing the Display Assembly (P/N 9800-2175)

Figure 5-2. Display Assembly

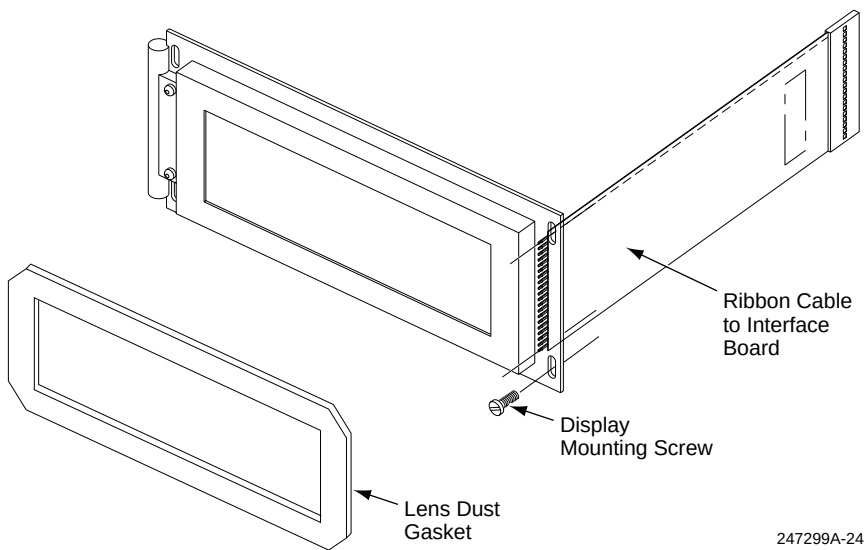
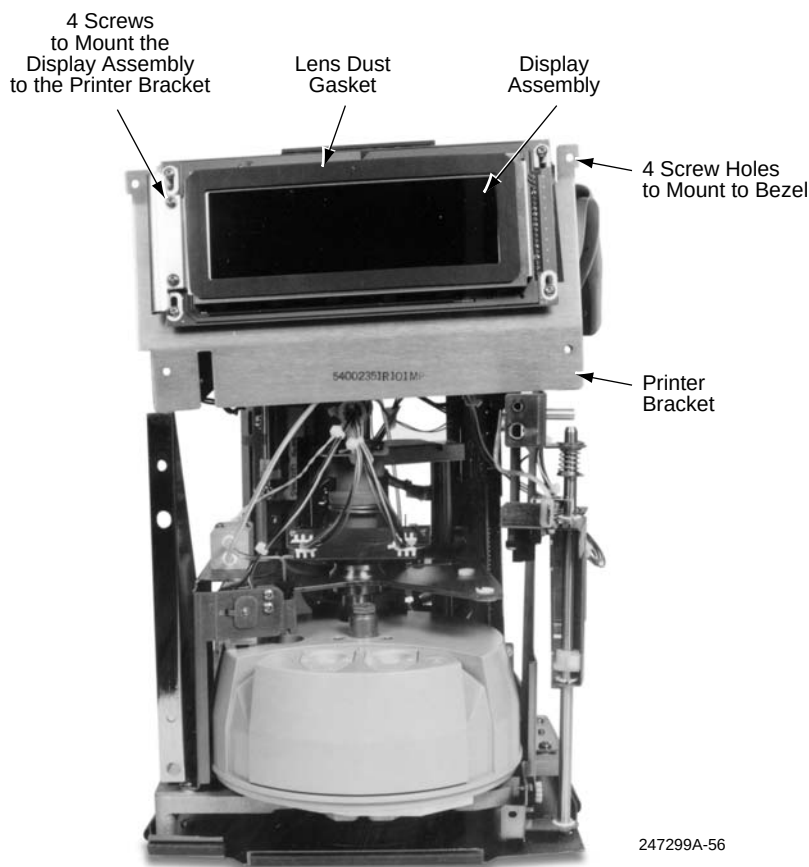


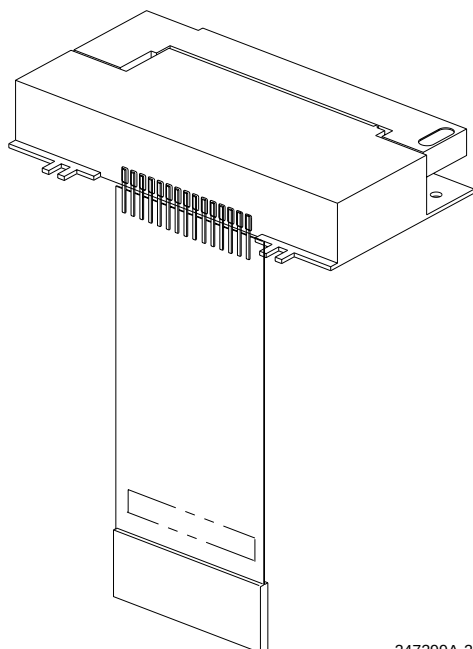
Figure 5-3. Replacing the Display Assembly



1. Remove 4 screws on back of bracket.
2. Remove the bezel (see Figure 5-1).
3. Remove 4 screws on the front of the display assembly.
4. Disconnect the ribbon cable from the interface board.
5. Remove the old display assembly.
6. Before installing the new assembly, place the new lens dust gasket (P/N 5400-2352) on the LCD of the display assembly.
7. Install the assembly by tightening the 4 screws to the printer bracket.
8. Install the bezel.

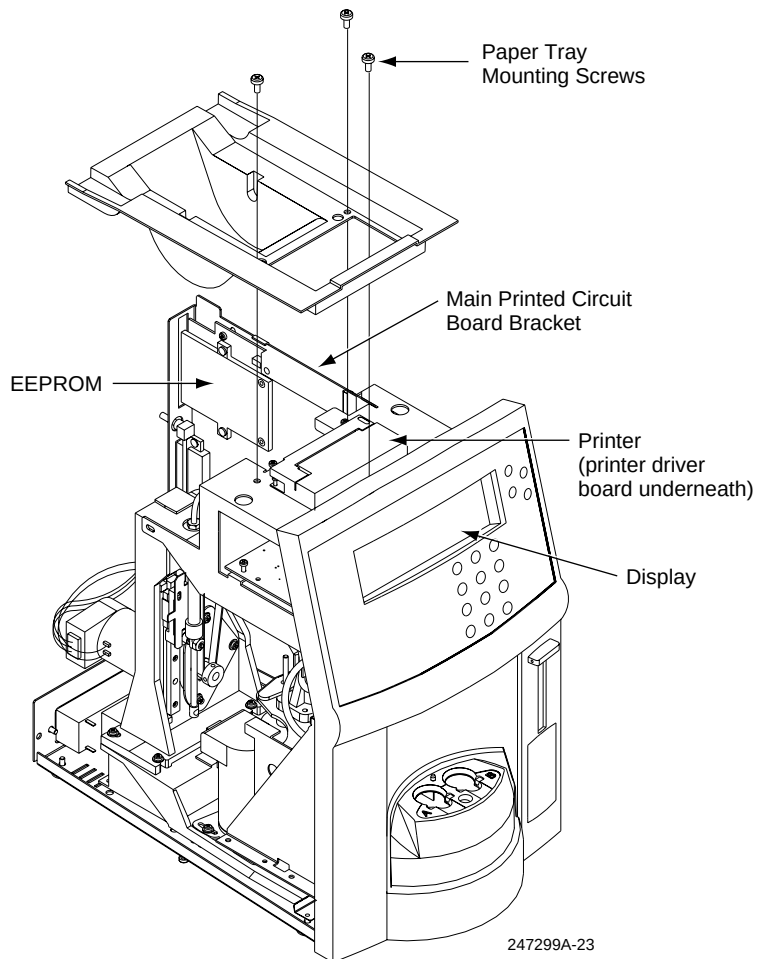
Replacing the Printer Assembly (P/N 9800-2174)

Figure 5-4. Printer Assembly



247299A-26

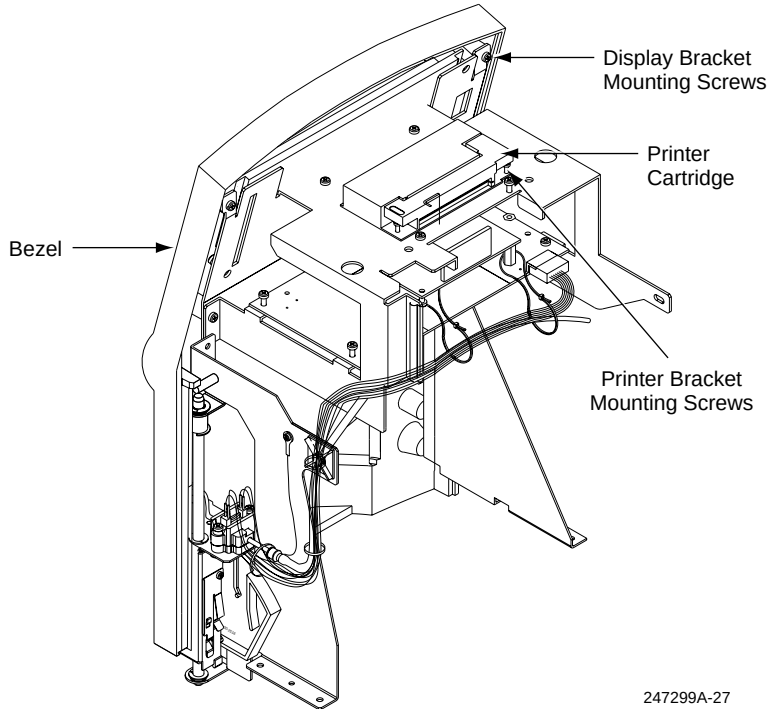
Figure 5-5. Detaching the Paper Tray



1. Remove 3 screws to detach the paper tray.
2. Remove printer cartridge from printer assembly and discard.
3. Disconnect ribbon cable from the PC board.
4. Remove 4 screws from the printer bracket.
5. Take the printer off the bracket.

(Procedure continued on next page.)

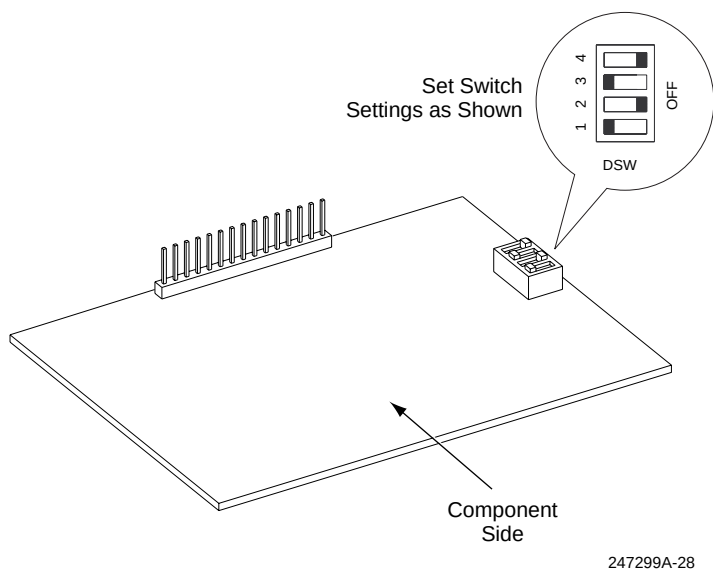
Figure 5-6. Removing the Printer Assembly



6. Remove the cartridge from the new printer assembly.
7. Tighten printer assembly using 4 screws.
8. Connect ribbon cable.
9. Install the printer cartridge.
10. Install paper tray using 3 screws.

Printer Driver Board Assembly (P/N 9800-2173)

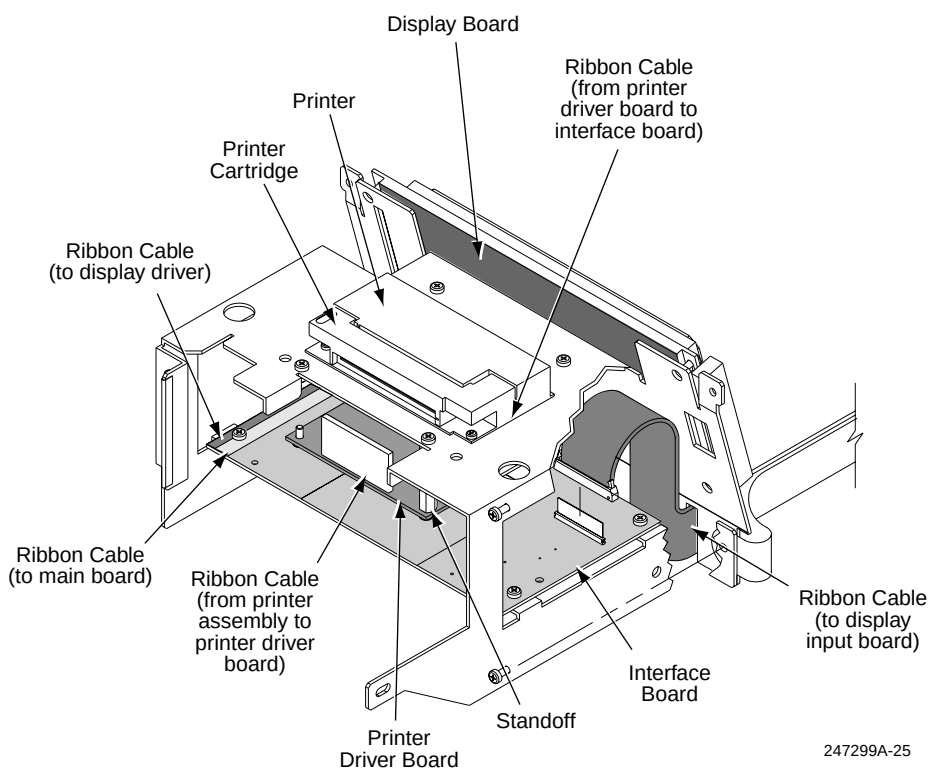
Figure 5-7. Printer Driver Board Assembly



1. Unplug both printer cables to connectors: printer board to printer cable and printer board to interface board.
2. Remove 4 standoffs from printer driver board, and remove the EMI spring strip.

(Procedure continued on next page.)

Figure 5-8. Removing Cables and Boards from Instrument

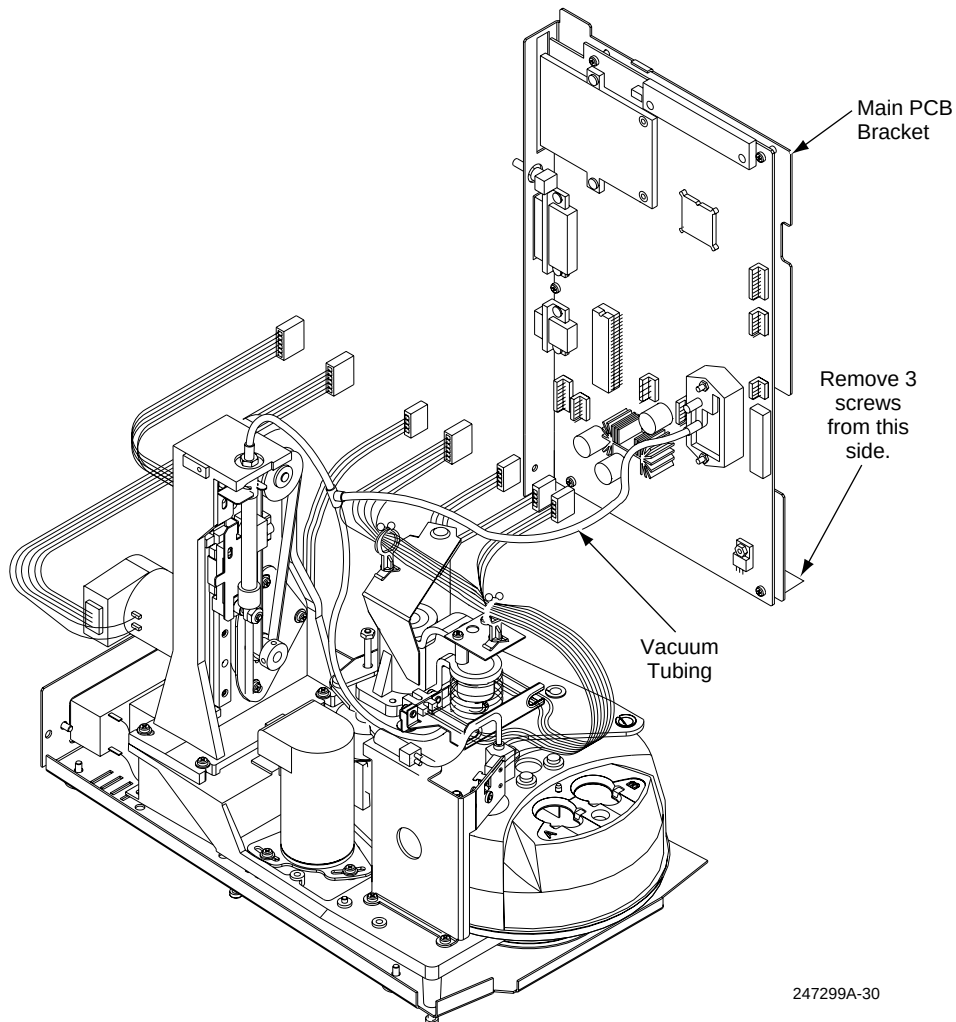


3. Set the printer settings (refer to Figure 5-7).
4. Connect printer ribbon cable from the interface board to the new printer driver board.
5. Plug printer ribbon cable to printer driver PC board.
6. Attach 4 standoffs and EMI spring strip to printer board.
7. Install printer driver board to the bracket. Component side is facing the printer bracket.

Replacing the Main PC Board Bracket Assembly (P/N 9800-2150)

Warning! *Make sure instrument power is OFF before replacing this assembly.*

Figure 5-9. PCB Bracket Assembly



1. Disconnect all cables attached to the PCB bracket.
2. Disconnect vacuum tubing from the PCB bracket.
3. Remove 3 screws on the PCB bracket.
4. Remove the old PCB bracket assembly.
5. Connect cables attached to lower portion of the PCB bracket.
6. Mount the new PCB bracket assembly to the baseplate using 3 screws.
7. Connect remaining cables to the PCB bracket.
8. Connect vacuum tubing to the PCB bracket.
9. Recalibrate the AIL, TC, and pressure set points. Enter S/N of instrument.

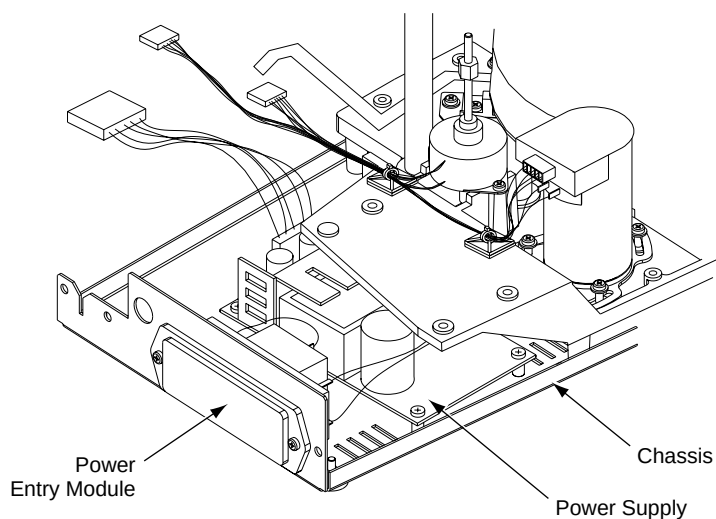
Power Supply

Error Message: If Instrument is Not Operating (no power)

If the system fails to power on when the switch is in the “On” position, the power supply may be dead. Check the electrical source and replace the baseplate assembly (power supply included).

Replacing the Baseplate Assembly (P/N 9800-2160)

Figure 5-10. Power Supply



247299A-29

1. Turn the instrument on its side.
2. Disconnect wire connecting power supply to the main PCB bracket.
3. Remove 2 screws attaching the main PCB bracket to the baseplate.
4. Remove 4 screws on the back of baseplate.
5. Reverse steps to install new baseplate assembly.

Section 6: Service Spare Parts

Part Number	Description	Location of Replacement Procedure
3106-2422	Fuse, Slo-Blo, 250V, 1.5 AMP	
4200-0116	Power Entry Module, PFA	Section 5
4200-0124	Interface Board	Section 5
4220-0177	Interface Board	Section 5
4200-0124	LCD Backlight Driver, PCB	
5400-2352	LCD Lens Dust Gasket	Section 5
5400-2354	Clamp, Block, AIL Sensor	Section 4
5400-2372	Fitting, Motor End	Section 3
5400-2644	Tube, Dispense	Section 4
5400-2655	Needle Assy, Bottle, Laser Weld	
5601-0847	Belt, Carousel Drive	Section 2
5601-0848	Belt, Syringe Pump Timing	Section 3
5601-0866	Tubing, Tygon, .031 ID, 3/16 OD	Section 4
5601-0886	Syringe, 1000 uL, K Tip	Section 3
5601-0891	O-Ring, Vacuum Seal, PFA	Sections 3, 7
5601-0916	Tubing, Microline, .05 ID	Sections 3, 4
5601-0919	Connector, Tubing, 1/16	Section 4
5601-0934	Tubing, Teflon FEP, .063 ID	Section 4
5601-0966	Pump, Solenoid, Self-Priming	Section 4
5601-0970	Fitting, T, Kynar, 1/16-1/8	Section 3
5601-0971	Tubing, Silicon, 3/32 ID	Section 3
5601-0972	Tip, Syringe	Section 3
9800-2150	Assy, Main PCB Bracket, PFA	Section 5
9800-2154	Assy, Vacuum Chuck INT Sensor, PFA	Section 3
9800-2157	Assy, Vacuum Head, PFA	
9800-2160	Assy, Baseplate	Section 5
9800-2161	Assy, Vacuum Chuck Motor, PFA	Section 3
9800-2165	Assy, Heater Block, PFA	Section 2
9800-2166	Assy, Type Code Sensor, PFA	Section 4
9800-2169	Assy, Bottle and AIL Sensor, PFA	Section 4
9800-2170	Assy, Traveler, Trigger Bottle, PFA	Section 4
9800-2171	Assy, Ribbon Cable (main PC board to interface board)	Section 5
9800-2172	Assy, Ribbon Cable (printer driver board to interface board)	Section 5
9800-2173	Assy, Driver, Printer, PFA	Section 5
9800-2174	Assy, Printer, PFA	Section 5
9800-2175	Assy, Display, PFA	Section 5
9800-2584	Assy, Sensor, Syringe, PFA	Section 3
9800-2587	Assy, Vacuum Chuck w/ load BTN, PFA	Section 3
9800-2633	Kit, Syringe Pump Motor w/mounting plate and pulley, PFA	Section 3
9800-2634	Kit, Carousel Pump Motor w/mounting plate and pulley, PFA	Section 2
9009-0298	Kit, Service (includes alignment tools)	

How to Order Spare Parts

Spare parts can be ordered through Dade Behring ISD Parts Order entry by calling the toll-free number, 1-(800) 323-9098. Select option 2.

Preventive Maintenance

Other than cleaning the instrument and replacing consumables listed below, the maintenance is limited to cleaning the O-ring.

Description	Specifications	Catalog #
O-Ring Cleaning Pads	Pkg. Of 35	B4170-73
Priming Cartridges	Pkg. Of 10	B4170-74
Vacuum Test Cups	Pkg. Of 35	B4170-75
Bar Code Reader	optional	B4170-6

Cleaning the O-Ring (P/N 5601-0891)

1. Locate the O-ring cleaning pads provided with the instrument.
2. From the System Ready display, press the softkey located next to [Menus].
3. Press the numeric key “2” to select the Maintenance option.
4. Press the numeric key “5” to select Clean O-ring option. The system will rotate the carousel and display the message Load O-ring Cleaning Pad. Press Continue.
5. Place the O-ring cleaning pad in the well and apply 4 drops of isopropanol to the center of the pad. Press gently on the pad with gloved index finger two to three times to help distribute isopropanol.
6. Press the key located next to [Continue]. The system will turn the carousel to the test cartridge loading position and bring the O-ring in contact with the cleaning pad.
7. After approximately 30 seconds, the carousel will rotate back, allowing removal of the pad. Dispose of the pad in a suitable biohazard waste container.
8. Press the softkey located next to [Continue].
10. Press the softkey next to [Previous Screen] twice to return to the System Ready display.

Instrument Decontamination Procedure

Required Equipment

Personal Protective Equipment

- Disposable Gloves
- Disposable Lab Coat
- Safety Glasses with Side Shields (or splash-resistant goggles)

Additional Supplies

- Labeled Spray Bottle (to hold decontamination solution)
- Package of Paper Towels (to apply decontamination solution and wipe spills)
- Dade International “Certificate of Decontamination” Card
- Packing Slip Sleeve (to place “Certificate of Decontamination” onto instrument)
- Decontamination Solution 1:10 (1 part bleach to 9 parts water): obtain from laboratory
- Tools (for disassembly of analyzer): use your own tools
- Deionized water: obtain from laboratory
- Biohazardous waste bag: obtain from laboratory

Decontamination Procedure

Warning: <i>Be sure the instrument is decontaminated in an area designated as a biohazard area.</i>

Note: If possible, use a wipe method instead of a spray method to apply the decontamination solution. If a spray method is used, ensure that droplets of solution, rather than a mist, are expelled from the container.

1. Power-down the instrument and unplug the power cord from the AC outlet.
2. Put on lab coat, safety glasses or goggles and gloves (latex are fine).
3. Using materials from the lab, mix a fresh batch of decontamination solution (1 part bleach to 10 parts water). Decontamination solutions must be mixed fresh daily.
4. Spray decontamination solution on areas where there is visible contamination with blood, blood products or other body fluids. Typical buildup occurs on the areas around the test cartridges. If heavy buildup is visible, soften the debris by spraying decontamination solution on the area, letting it sit, then wiping up with a paper towel or other absorbent material. Spray decontamination solution on the area again and allow it to sit for 20 minutes.

(Procedure continued on next page.)

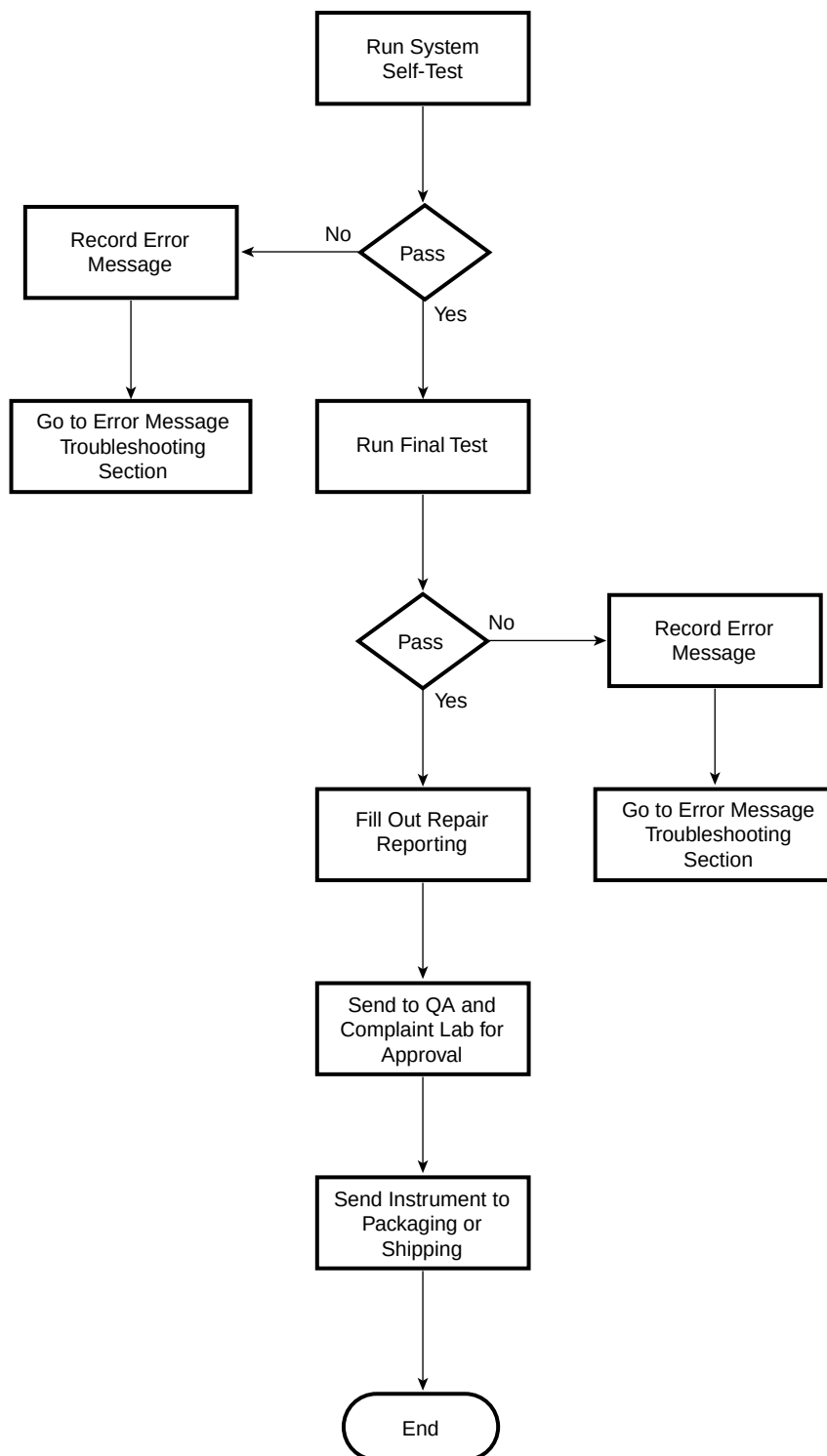
5. Apply decontamination solution to all external surfaces and allow it to sit for 20 minutes, then rinse with deionized water.
6. Remove and place any used test cartridges into a biohazardous waste container. Have the laboratory dispose of these materials in accordance with their biohazardous waste disposal policies and procedures.

Warning: <i>All biohazardous materials must be removed and disposed of properly. The instrument cannot be admitted to the product repair center if biohazardous materials are not removed.</i>
--

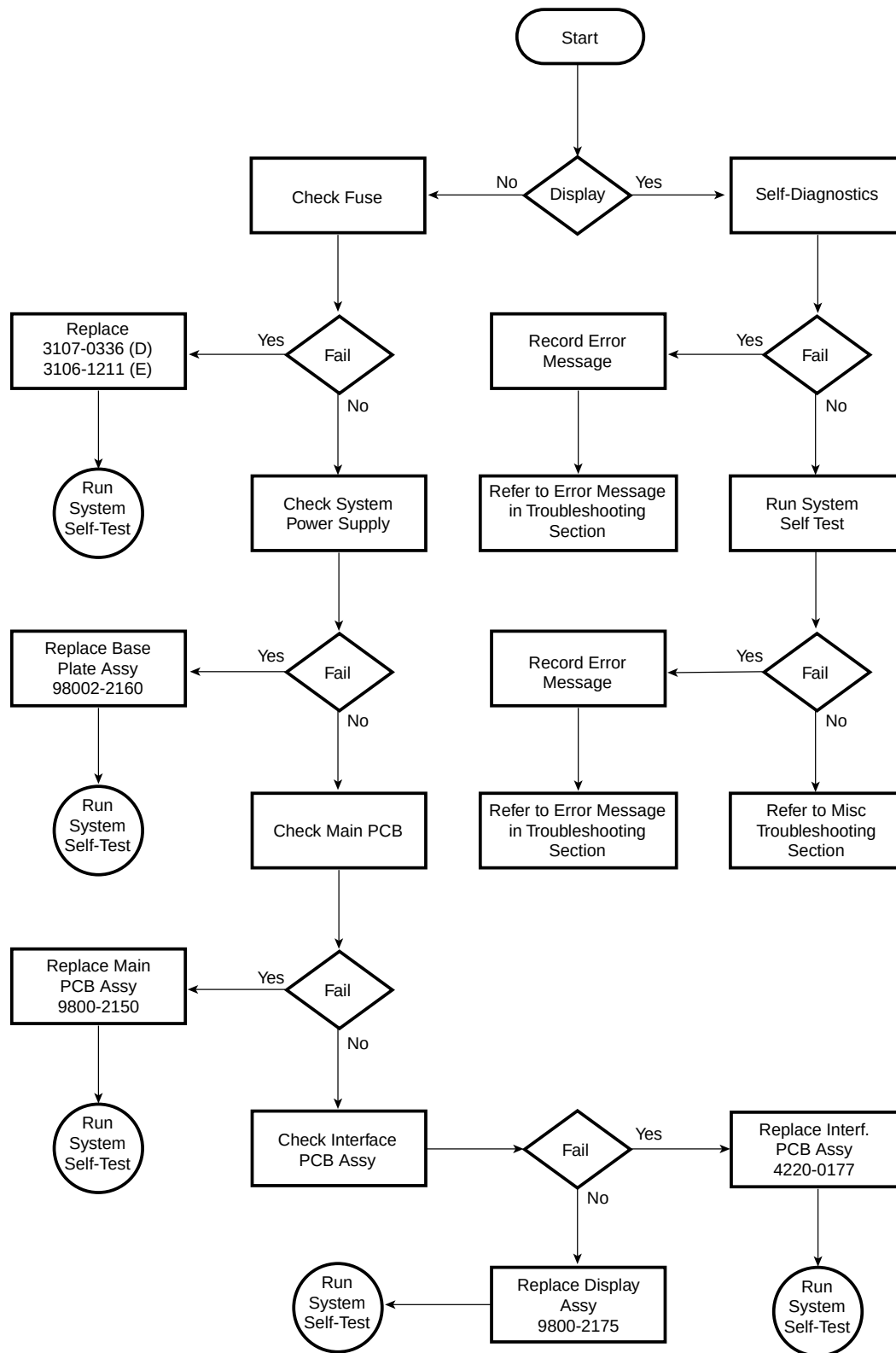
7. Dispose of biohazards as instructed by laboratory.

Section 8. Quick References

Self-Test Troubleshooting Diagram



247299A-33

PFA-100 Troubleshooting System Diagram

247299A-32

Appendix: Technical Information

Main Board

The main board (mounted vertically inside the instrument) coordinates the operation of the entire system. The 8-MHz processor chip provides the instructions, timing, and calculations for the system. The instruction code for the microprocessor are stored in an EEPROM memory device. Future enhancements or changes to the instruction code can be easily updated in the field by use of a PCMCIA card that plugs into a slot in the back of the unit. The EEPROM maintains the software setups when the instrument is powered OFF.

Microprocessor

The PFA-100® is controlled by a Motorola 68HC16Z microprocessor. It is a 16-bit high-speed device that interacts with the memory and peripheral devices through a standard bus and bus interface. The processor contains the A/D converter that digitizes the vacuum sensor signal. The processor also contains decoding circuitry that is configured under program control to generate the chip select signal for each memory and peripheral device.

Processor Analog to Digital converter -10 Bit resolution (5 mv/count)

Ranges and Conversion Factors

Vacuum sensor output range: 0–1 PSI = 0–5 v dc (after one volt offset is removed)

Conversion to millibar: 1 mbar = 1.4504×10^{-2} psi

1 mbar = 1.4504×10^{-2} (5 v) = 72.25 mv/mbar

The processor can resolve 5 mv or approximately 0.07 mbar.

Reset Monitor

Reset of the microprocessor is controlled by a Dallas semiconductor DS1233-15 reset monitor (U7). At power on the DS1233 holds RESET low as V cc rises towards +5 V dc. RESET is kept low for an additional 350ms after Vcc is in tolerance (>4.0 V for the –15 part) to allow time for the power supply and processor to stabilize. At power-down RESET is asserted within 100 ns after V cc falls below 4.0 V dc. Pushbutton switch SW1 does not activate the “pushbutton reset” function of U7 due to the isolating effect of diode D1. SW1 causes a direct hard reset by pulling the reset line to ground. The RESET signal is connected to the following devices: Processor U4, servo controllers U11 and U19, servo driver U21, heater switch Q1, and the LCD display.

System Memory

System memory is partitioned into three chunks. An 8K EPROM chip (U8) contains startup/initializing code and the code that handles software updates through Flashcards. A 256K Flash memory chip (U9) contains the operating code. A 128K nonvolatile RAM chip (U10) is used for general-purpose RAM and for storing test results and user options.

Flash Memory

The flash memory can be reprogrammed by inserting a flashcard containing PFA-100[®] software into the memory card connector (JP1) at the rear of the instrument. The presence of a flashcard is automatically detected and “upgrade” code from the EPROM is executed to erase the flash memory chip (U9) and reprogram it with the new software from the flashcard. Programming voltage V_{pp} is supplied under processor control from the V_{pp} generator U6.

Memory Card Connector

The memory card connector provides an easy way to revise the operating software. The system software continuously checks for the presence of a card at the memory card connector. When a memory card is detected, the contents of the flash memory chip is erased and the new program from the memory card loads into the flash memory chip. At the end of the software transfer, the power-up initialization routine is started and the new version of software is operational.

Motion Control

Servo Motor Drive System

The carousel and syringe motors are controlled by identical, but independent, closed-loop Pulse Width Modulation (PWM) servo systems. Each system consists of a controller, driver, motor, and a motor-mounted incremental encoder.

Servo Controller

The LM629 servo controllers (11, U19) receive ASCII commands from the processor to set-up move profiles. A profile consists of acceleration/deceleration information along with speed and position targets. When a START command is received, the LM629 moves the motor to the desired target position using the current profile. The encoder provides position feedback to the controller so it can adjust its pulse width modulation (PWM) and direction signals to maintain the motor at the proper speed or position.

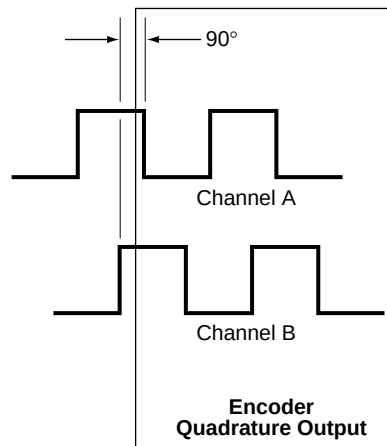
Servo Driver

Two independent H-bridge drivers are contained in U21, and L298. Each H-bridge receives a PWM and direction signal from its respective controller. The direction signal determines the polarity of the motor out signals (determines motor direction) and the PWM signal sets the on-time of each PWM cycle (determines motor current, which equates to motor speed). The four diodes on the driver outputs clamp inductive spikes to one diode drop below ground and one diode drop above the +12 V dc motor voltage.

Encoder

Each servo motor has an incremental encoder attached to monitor the speed of the motor shaft. The encoder output consists of two square waves in a quadrature relationship. The pulse rate of these signals is proportional to the speed of the motor shaft. The encoder outputs information that the controller uses to maintain the motor shaft at the commanded speed or position. In the illustration below, channel A leads channel B. If the direction of rotation were reversed, channel B would lead A by 90°.

Figure A-1. Encoder Output



Stepper Motor Driver

The linear actuator that raises and lowers the vacuum chuck is driven by U24, a PD3517N stepper motor driver. Each pulse on the STEP input advances the four outputs to the next state of a four-state sequence (eight states if half-stepping is used), causing the motor lead screw to rotate. The DIR input determines the direction of output sequence and therefore direction of rotation of the motor's lead screw. The speed of the motor is determined by the pulse rate that the processor outputs to the STEP input of U24. With power applied, the motor will hold its position until pulses are received on the STEP input. Asserting the INH (inhibit) input turns off the four outputs of the PD3517 and removes power from the motor. The eight diodes on the outputs limit inductive spikes to one diode drop below ground to one diode drop above the +12 V dc motor voltage.

Heater Controller

The heater controller consists of the PWMA output of the processor, FET transistor Q1, the heating element, a thermistor, and a snap-action thermostat. The processor's PWMA output controls Q1 to apply power to the heating element. The thermistor and resistor R25 form a voltage divider that provides an output voltage proportional to thermistor temperature. The temperature set point is 37.9°C. At this temperature, the thermistor signal voltage (measured across R25) will be 2.470 V dc. The processor applies power to the heater until the thermistor is at the setpoint temperature. Then power is turned off until the thermistor temperature fall to 37.6°C. This cycle repeats to maintain the average temperature near the setpoint. The resistance of the heating element is $1.92\ \Omega \pm 10\%$. The snap-action thermostat opens at 70°C to limit the temperature rise if there is a fault in the heater system.

Display

The display is an 8-line by 40-character backlit liquid crystal device, but in PFA, every other line is skipped to achieve a better presentation. Data is input in parallel from the high-order 8 bits of the processor data bus after being buffered by U2. The display operates from the 5 V dc supply. It is reset from reset ckt U7. Potentiometer VRES1 on the main PCB controls the level of back lighting.

Peripherals

RS-232 Outputs

Two RS-232 serial ports are at the rear of the instrument. Connector JP5 (25-pin D type) supports connection to an external computer. Connector JP8 (9-pin D) supports input of patient ID from an RS-232-compatible bar code reader. Baud rate generation and serial port registers for both ports are located in an MC2681P peripheral support chip U16. Port A is the external computer port, port B is for the barcode reader. U15, a MAX248CQH provides buffering and level shifting between -5 volt logic and the ± 10 V levels of RS-232. U15, an SP720AP, provides Electrostatic Discharge (ESD) and overvoltage protection the RS-232 signal lines.

Barcode Reader

The system is able to accept patient ID input from an external barcode reader.

- The barcode reader is configured to provide formatted output (i.e., prefix and suffix characters) to check for errors on the incoming data.
- If an erroneous data packet is received, the data will not be accepted and the operator will be expected to re-scan the ID.
- If the data received exceeds the maximum allowable PID length (12 characters), then the message "MAXIMUM PID LENGTH EXCEEDED!" will be displayed and the data will be rejected.

- Once a valid patient ID has been received:
 - If the operator selects “RUN,” the system accepts the patient ID.
 - If the operator presses one of the numeric keys, the system will erase the existing patient ID and replace it with the character representing the key just pressed.
- If the operator enters a patient ID with the system keypad and then scans a barcode label, the current patient ID displayed will be replaced with the barcode scanned ID.
- The following code symbologies are supported:
 - Code 3 of 9
 - Code 128
 - CODABAR
 - UPC
 - EAN/JAN
 - Interleaved 2 of 5
 - Code 2 of 5
 - MSI
 - Code 93

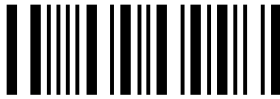
Use the barcode wand to scan each barcode (see Figure A-2) in *sequential* order. After the barcodes have been scanned successfully, the ScanTeam 3400 is programmed and ready for use with the PFA-100®.

Figure A-2. Barcode Labels for Scanning

Set the default RS232 interface:



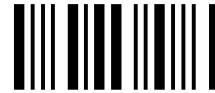
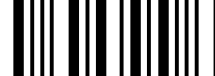
Set the terminal interface to RS232 true:



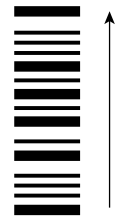
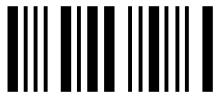
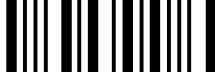
Set the default prefix and suffix:



Set the prefix:



Set the suffix:



247299A-61

Sensors

Vacuum Sensor

The vacuum sensor (U20) measures the vacuum created in the test cartridge during a test. Its measurement range is 0–1 psi (0–68.9 mbar). The output of the sensor is in the range of 1–6 volts. For maximum accuracy, the sensor's operating voltage is derived from precision reference U22 and amplified to 8.0 V by one section of opamp U23. Port 1 is the measurement port; port 2 is left open to the atmosphere.

Signal Conditioning

The vacuum sensor output is applied to the inverting input and opamp (U23) where it is summed with -1 volts ($-5\text{V} \times R30/R28$) to remove the sensor's one volt offset. A second opamp performs an additional inversion so that the signal is once again positive and in the range of 0–5 volts. This is the signal that is digitized by the A/D converter in the processor. Resistor R39 and Capacitor C17 provide noise filtering for the vacuum sensor signal. Diodes D5 and D6 provide overvoltage protection to the processor's A/D converter input. Should a fault cause the opamp output to go to the + or - 12 V rail the diodes will clamp the input to the processor to about 5.7 or -0.7 volts.

Cartridge Identification (TC) Sensor

The type code sensor provides cartridge type information to the processor by detecting the slots (0–4) in the top of each cartridge. The emitter of the sensor projects a beam of IR light onto the top of the cartridge as it passes under the sensor. The solid areas of the cartridge reflect the IR beam to the detector section of the sensor (the slots do not reflect light). Sensor output is logic 1 for a slot and logic 0 when no slot is under the sensor. The input to the emitter side of the sensor is a pulse train from the processor's PWMB output buffered by section C of U3. PWMB drives the emitters of both the TC and AIL sensors. This is not a problem because both sensors are not active at the same time.

Air-in-Line Sensor

This sensor (located above the trigger bottle) detects air and air bubbles in the tubing connected to the trigger bottle. The sensor is an optical interrupter type sensor mounted in a housing that positions the tubing in the sensor's optical path. Air or bubbles produce a low output. Trigger solution without bubbles produces a high output. The sensor's emitter is driven from the processor's PWMB signal buffered by section C of U3. PWMB also drives the emitter TC sensors. This is not a problem because the two sensors are not active at the same time. When the AIL sensor is active, the PWMB signal is at a constant logic one ($> 4\text{ V dc}$). The threshold of air in line detection is determined by software during AIL calibration.

Position Sensors

Optical interrupter type sensors are used as position sensors in the following areas:

- Detecting Carousel home
- Detecting syringe home
- Detecting vacuum chuck home (up) and test (down)

The emitters of these 4 sensors are powered from the 5 V dc supply through 180- Ω resistor. These detectors have open collect outputs pulled up by 10K- Ω resistors. The output of the carousel home sensor is connected directly to the processor. The other three sensor outputs go to PIA U16. The processor reads the input port register of U16 to get the status of these sensors. Sensor output is high when the emitter detector light path is interrupted by an opaque flag; otherwise, output is low.

Micro Pump

The micro pump is a 12 V dc solenoid-operated fixed-volume pump (40 μ L). It is controlled by the processor through section A of buffer/driver U3. When the solenoid is energized (JP6 pin 2 < 1 V dc) the pump aspirates 40 μ L of trigger solution from the trigger bottle. When it is de-energized (JP6 pin 2 $\cong$ +12 V dc) the pump dispenses the 40 μ L through the dispense nozzle.

Front Panel Keypad

The Keypad is arranged as a 4x4 diode matrix. It is driven directly from the processor by sequentially strobing the 4 signals labeled KD0–KD3. If a switch is being pressed when a strobe occurs, one of the four signals will be pulled low. The processor monitors the KS0-KS3 signals to determine which switch is being pressed.

Power Supply

The PFA-100[®] uses a Power-One MPB80-3000 to provide power to the instrument that is dc-isolated from the input. The supply features a +5 V, 7 A output with a line regulation of $\pm 1\%$; a +12 V, 2.5 A output with a line regulation of $\pm 1\%$; and a 12 V, 0.65 A output with a line regulation of $\pm 1\%$. This 12 V output is dc-isolated from the +5 V and +12 V outputs. The reference for this third output is tied to the common of the +5 V and +12 V outputs on the main board to produce the required -12 V source. This power supply can accommodate main voltages ranging from 85 V ac–264 V ac at frequencies ranging from 47 Hz–63 Hz. At maximum load, the power supply can sink 1.1 A (RMS) when operating with 120 V ac mains, and 0.55 A (RMS) when operating with 230 V ac mains. In addition, the power supply can support dc main voltages ranging from 110 V dc to 350 V dc as well.

The outputs couple to the main board at P2 and are used for the following functions:

TERMINAL	OUTPUT	FUNCTION
P2, pin 1	+12 V dc	servo motor, micro pump solenoid, heater
P2, pin 2	(ground)	logic ground
P2, pin 3	(ground)	sensor ground
P2, pin 4	+5 V dc	air sensor, type code sensor, printer
P2, pin 5	+5 V dc	all logic, LCD display, backlight, stepper motor
P2, pin 6	-12 V dc	servo motor, heater

Precision Voltages

Two precision or clean voltages (–5 and 8 V) are necessary to power the analog circuitry on the main PCB. However the main power on the PCB contains switching noise, therefore is not a suitable candidate. Because of this, U22, a precision voltage reference, is used to produce a clean –5 V output.

In turn, this –5 V output drives two other analog circuits. The first circuit is a unity-gain inverting amplifier that produces a clean –5 V. This –5 V is used in the vacuum sensor's signal conditioning circuitry. The second circuit is a non-inverting amplifier with a gain of 1.6 that produces a clean 8 V, which is used to power the vacuum sensor.

Printer

40-column inked ribbon printer. Receives serial data directly from the processor at 4800 baud. Operates from 5 V dc supply.

Printer switch settings for operation with PFA:

- Switch section 1 ON (selects serial mode)
- Switch section 2 OFF (correct orientation of printing for PFA)
- Switch section 3 ON (selects 4800 baud rate)
- Switch section 4 not used

Fusing

User-replaceable line fuse:

- 100–130 V ac line voltage 1/4 X 1 1/4-inch, 2 A one fuse (American)
- 220–240 V ac line voltage 5 X 20 mm, 2 A two fuses (European)

Nonuser-replaceable fuses on the main PCB:

- F1 1.5 A pico fuse. Protects stepper motor circuit
- F2 3.0 A pico fuse. Protects both syringe and carousel servo driver circuits.